PANOCHE DRAINAGE DISTRICT

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July 11, 2008

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Subject: San Joaquin River Water Quality Improvement Project, 2007 Wildlife Monitoring Report

Enclosed is the 2007 Monitoring Report (2007 Report) for the San Joaquin River Water Quality Improvement Project (SJRIP) prepared by H. T Harvey & Associates. This is the seventh year of bird egg monitoring at the project site. Eggs were collected from recurvirostrids (black-necked stilt and American avocet), killdeer, and red-winged blackbirds.

The overall geometric mean selenium egg concentrations for recurvirostrids from the project area in 2007 (16 eggs) was 16.7 ppm (dry weight). This was less than 2006 (17 eggs) 23.0 ppm (dry weight) and 2005, which were 35.3 ppm (dry weight).

The following measures were implemented in 2007 to reduce exposure potential and mitigate exposure to birds.

1) **Reduced exposure potential by reducing attractiveness of drainage ditches for nesting**: Monitoring efforts detected that some drainage ditches within the project site were attracting nesting shorebirds. Shallow water pooling in unused drainage ditches was also observed to provide foraging habitat for killdeer, black-necked stilts, and American avocets, thereby serving as a pathway for selenium exposure. Additionally, silt collecting at the bottom of these drains was

providing a nesting substrate for shorebirds. Irrigation and drainage ditches within the project site were, therefore, re-contoured prior to the nesting season to reduce their attractiveness to foraging and nesting shorebirds.

2) **Reduced exposure potential by hazing birds from nesting near, and foraging in, irrigation (and drainage) ditches**: A hazing program has been implemented by shooting "cracker shells" in the vicinity of birds to discourage nesting within the project area.

3) **Flooded field contingency plan**: Panoche Drainage District has had a flooded field contingency plan in place since a field was inadvertently flooded in 2003. A copy is included in Appendix H of the 2006 Report.

4) **Provide mitigation breeding habitat**: Fifty acres of mitigation habitat were constructed as described in the 2006 Report. The monitoring program was expanded to include monitoring of the mitigation site during the spring of 2006. Twenty-one recurvirostrids and seven Killdeer nested within the mitigation habitat off of the project site. The geometric mean selenium concentration for recurvirostrids was 10.6 ppm (dry weight).

5) **Reducing exposure to open drains:** The District closed open drains that were not needed for current project activities on the site and netted other drains as a temporary measure. Seven miles of drains were closed and another four miles of drains were temporarily netted to exclude birds (see attached photos).

If you compare the location of the recurvirostrid eggs that were collected in 2007 (see Figure 5) to 2006 (see attached Figure 5 from the 2006 report) and compare these locations to the drains that were either closed or temporarily netted (Figure 2), you will seethat there were no nest attempts where bird access to open drains had been prevented. This confirms that the mitigation measures were effective in moving birds away from these areas.

The attached figure shows that in 2007 recurvirostrid egg levels lowered to a geometric mean of 16.7 ppm (dry weight), compared to the 23.0 ppm in 2006. Reductions were also observed for killdeer and red-winged blackbirds.

In 2007 recurvirostrid egg selenium levels at the mitigation site were approximately equal to the project site. This could be because of the close proximity of the mitigation site to the project area and to open drains nearby. In 2008 this site will be moved further north to try to avoid these types of interactions.

The density of recurvirostrids in the project site continues to be low. In 2007, 17 nest attempts were located within the 4,000-acre project site.

Future plans include piping of drains that are needed for project operation to further reduce the exposure potential. This would occur in place of the temporary netting and in additional drains as they are identified. This work has begun in the spring and summer of 2008.

Questions regarding this data should be directed toward Joe McGahan, Drainage Coordinator for the Grassland Bypass Project. He can be reached at 559-582-9237.

Very truly yours,

Dennis Falaschi
General Manager

Cc: Laura Myers
US Bureau of Reclamation
1243 N Street
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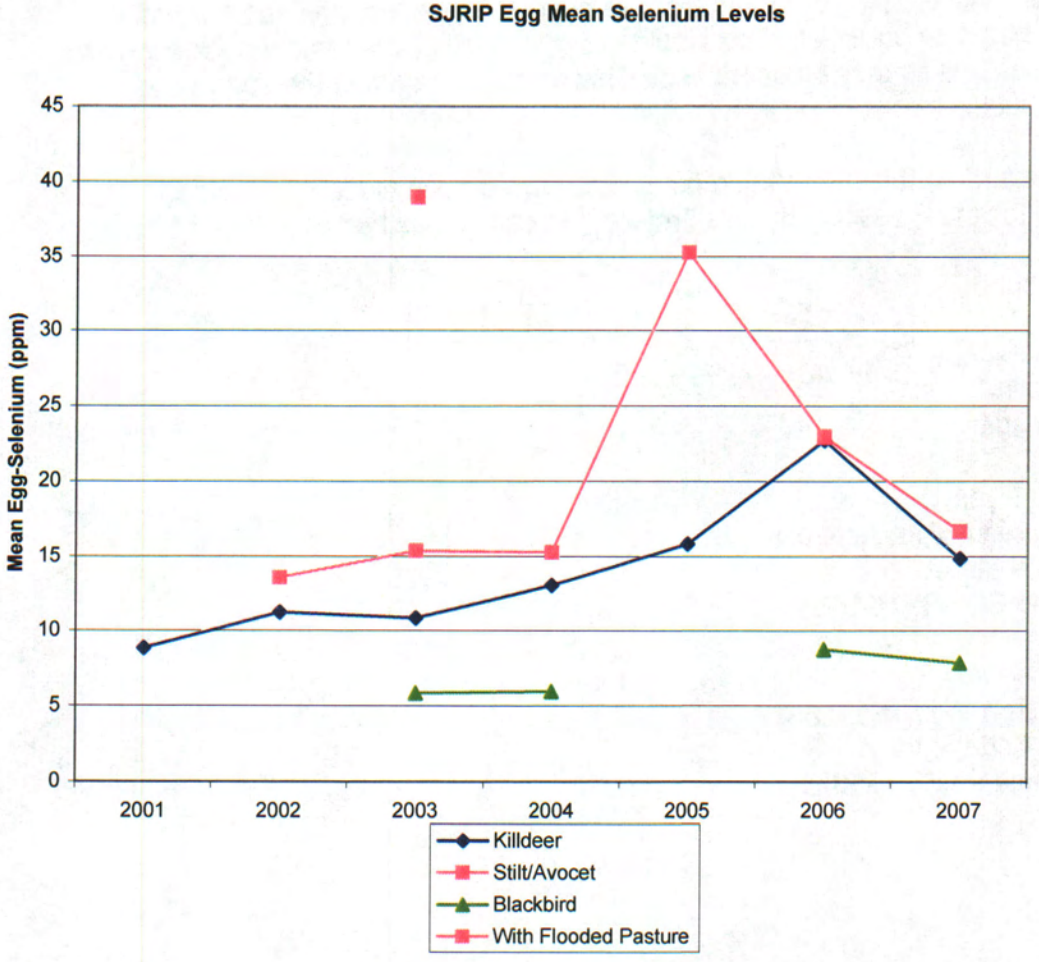
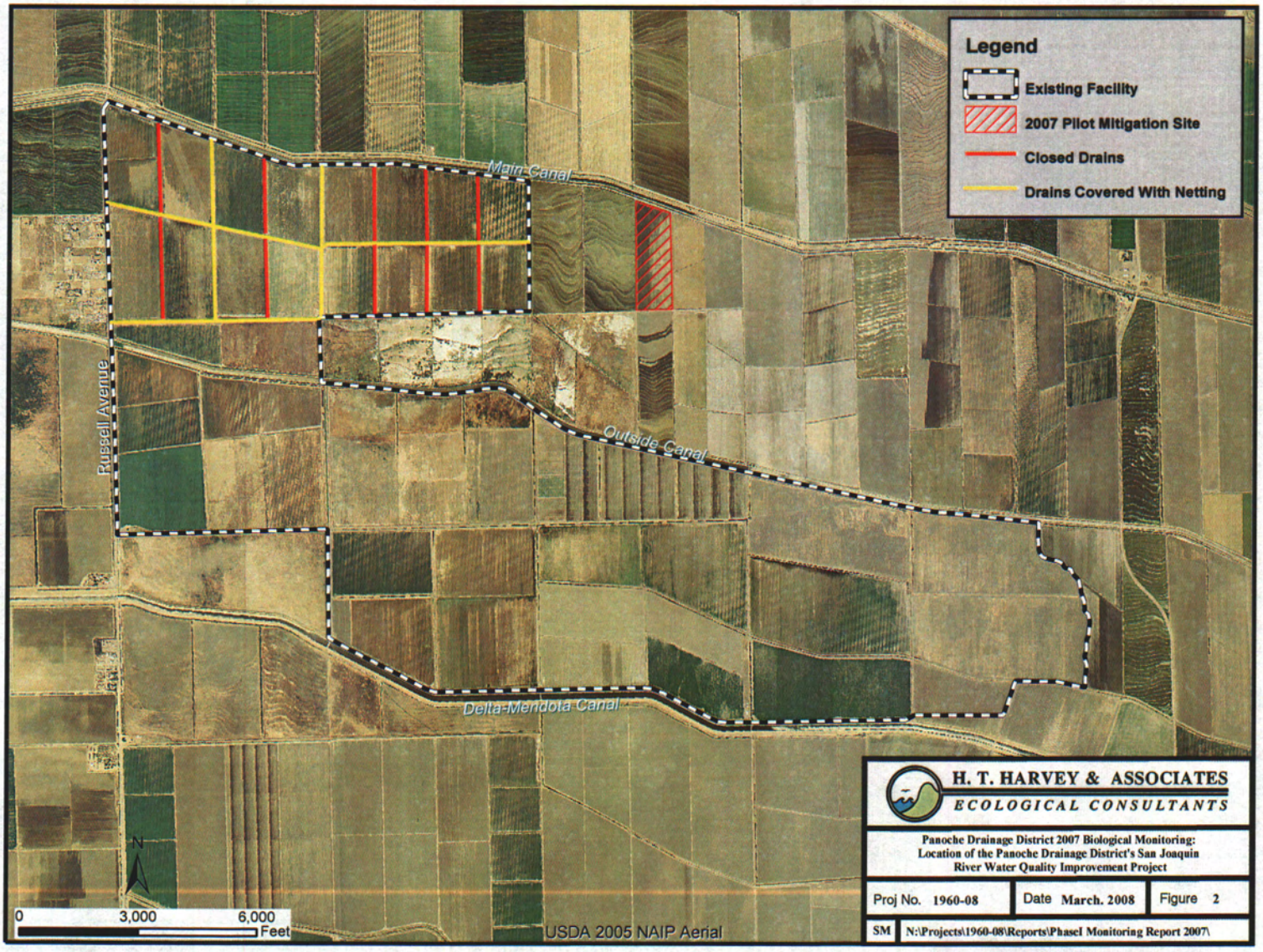
Tom Maurer
US Fish & Wildlife Service
2800 Cottage Way
Sacramento, CA 95825


SJRIP Egg Mean Selenium Levels
Mean Egg-Selenium (ppm)
45
40
35
30
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
Killdeer
Stilt/Avocet
Blackbird
With Flooded Pasture


Legend
Existing Facility
2007 Pilot Mitigation Site
Closed Drains
Drains Covered With Netting
Main Canal
Outside Canal
Delta-Mendota Canal
Russell Avenue
N
0
3,000
6,000
Feet
USDA 2005 NAIP Aerial
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
Panoche Drainage District 2007 Biological Monitoring:
Location of the Panoche Drainage District's San Joaquin
River Water Quality Improvement Project
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Date March. 2008
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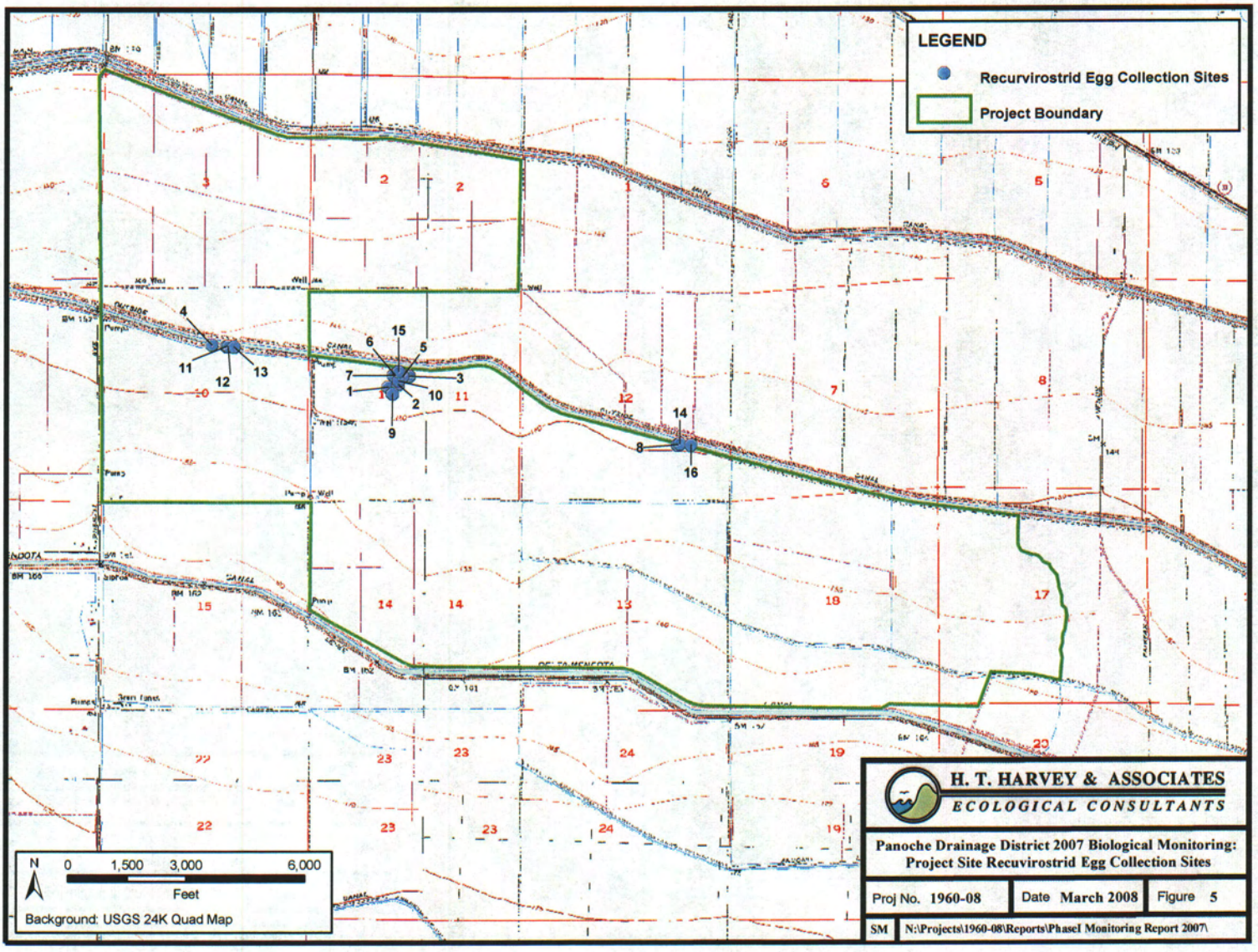
LEGEND
Recurvirostrid Egg Collection Sites
Project Boundary
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Feet
Background: USGS 24K Quad Map
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
Panoche Drainage District 2007 Biological Monitoring:
Project Site Recurvirostrid Egg Collection Sites
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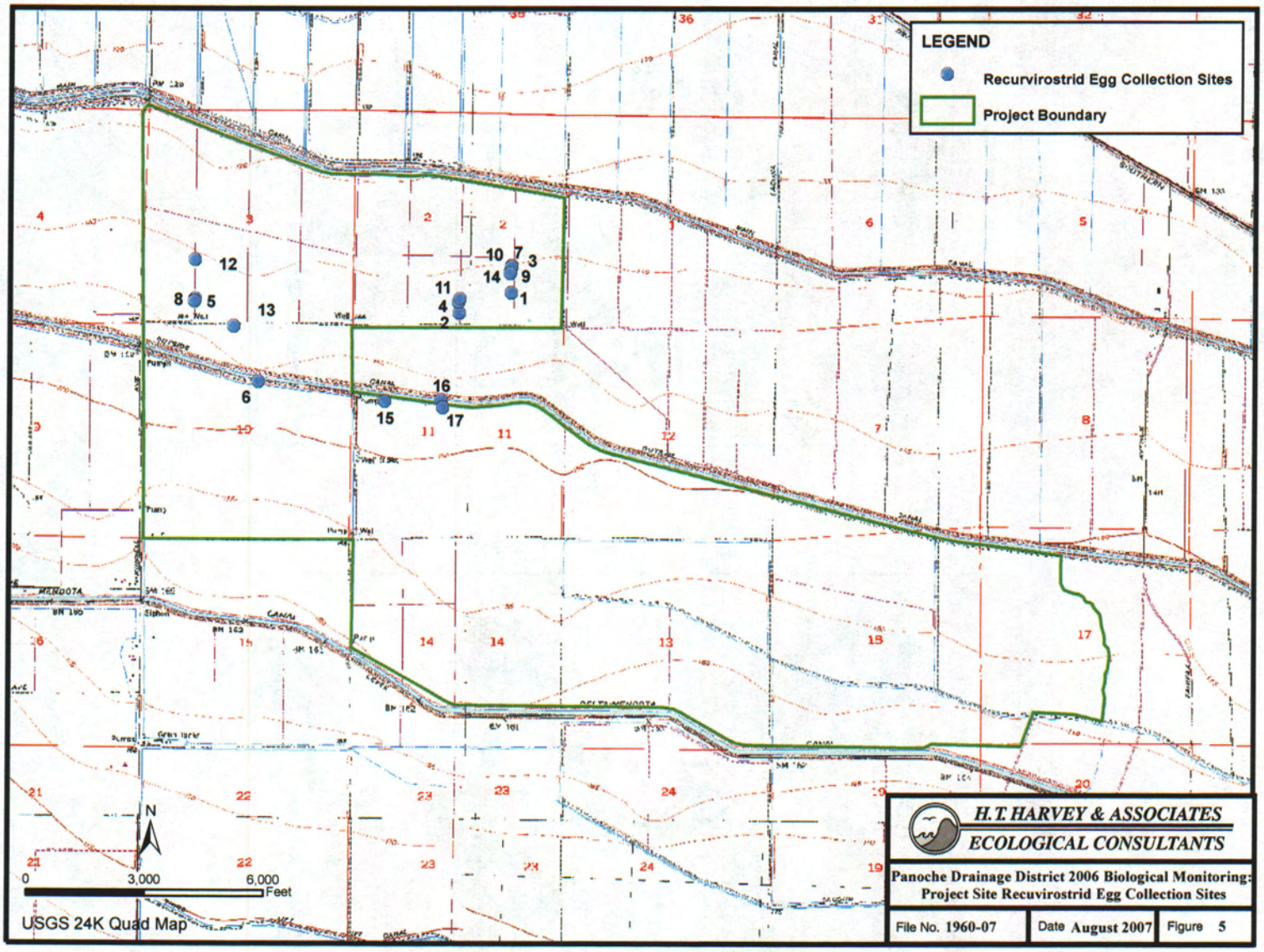

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Panoche Drainage District 2006 Biological Monitoring: Project Site Recuvirostrid Egg Collection Sites

File No. 1960-07	Date August 2007	Figure 5

H.T. HARVEY & ASSOCIATES
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SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT, PHASE I WILDLIFE MONITORING REPORT 2007

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Prepared for:

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Grassland Basin Drainers
C/O Joseph C. McGahan
Summers Engineering
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11 July 2008

File No. 1960-08

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CONTRIBUTORS

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Brian B. Boroski, Ph.D., Project Manager / Senior Wildlife Ecologist
Jeff Seay, B.A., Wildlife Ecologist
Mark D. Meyer, Ph.D., Wildlife Ecologist

INTRODUCTION

To reduce the amount of salt and selenium delivered to the San Luis Drain and Mud Slough through the Grassland Bypass Project, the San Luis and Delta Mendota Water Authority Grassland Basin Drainers implemented Phase I of the San Joaquin River Water Quality Improvement Project (SJRIP). The Panoche Drainage District, acting as the lead agency under the California Environmental Quality Act (CEQA), prepared a Negative Declaration for SJRIP in September 2000. The Negative Declaration included the provision of a biological monitoring program to be developed in collaboration with the U.S. Fish and Wildlife Service (Service), which would detect potential migratory bird impacts resulting from exposure to elevated levels of selenium due to the project. This report represents the biological monitoring results for the seventh year (2007) of Phase I of the SJRIP.

PROJECT DESCRIPTION AND SETTING

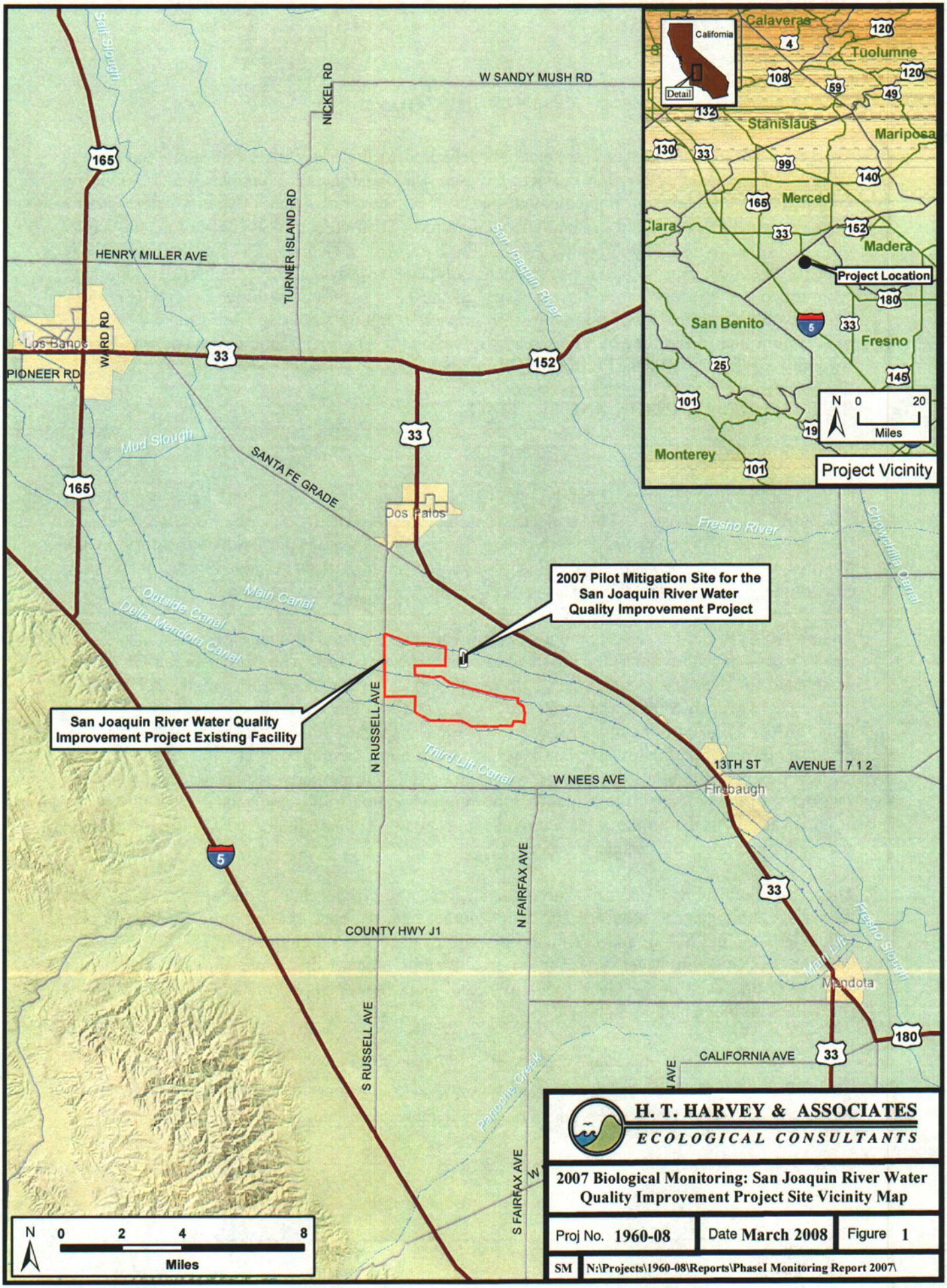
Existing Facility

Crops were planted on approximately 3873 of the 4000 acres obtained by the Panoche Drainage District as part of Phase I. The project site is located west of the city of Firebaugh in Fresno County, California (Figure 1). The irregularly shaped project site is bordered on the north by the Main Canal and on the south by the Delta-Mendota Canal. Russell Avenue borders the eastern edge of the project site and the western edge extends nearly to Fairfax Avenue (Figure 2).

The project is the initial development of an In-Valley Treatment/Drainage Reuse Facility on up to 6200 acres of land within the Grassland Drainage Area (GDA). The 6200 acres of GDA land designated for purchase is made up of irrigated field crops and related irrigation ditches, drain ditches, conveyance canals, and farm structures. The topography is nearly level to grade and flood/furrow irrigated. The highest elevation is found near the southeast corner at 164 feet above mean sea level, while the lowest point is found near a north-central point at 136 feet above mean sea level. Thus, the elevation change within the 6200-acre property is approximately 28 feet. The shape of the property is irregular, conforming to the area's adjacent canals. Russell Avenue provides access to the property via a paved county road. Typical, improved farm roads provide access to the interior of the site.

The reuse facility will dedicate specific lands for the irrigation of salt-tolerant crops with subsurface drainwater to reduce drainwater volume; treat the concentrated drainwater to remove salt, selenium, and boron; and eventually dispose of the removed elements to prevent discharge into the San Joaquin River. The reuse facility will process up to one-quarter of the total drainwater produced in the GDA (25% of 52,000 acre-feet or approximately 15,000 acre-feet) and will be implemented in 3 phases:

- Phase I: Purchase of land and planting of salt-tolerant crops
- Phase II: Installation of subsurface drainage and collection systems, initial treatment system
- Phase III: Complete construction of treatment removal and salt disposal systems


W SANDY MUSH RD
NICKEL RD
TURNER ISLAND RD
HENRY MILLER AVE
WARD RD
PIONEER RD
Los Banos
Mud Slough
San Joaquin River
SANTA FE GRADE
Dos Palos
Fresno River
Chowchilla Canal
Main Canal
Outside Canal
Delta Mendota Canal
2007 Pilot Mitigation Site for the San Joaquin River Water Quality Improvement Project
San Joaquin River Water Quality Improvement Project Existing Facility
N RUSSELL AVE
Third Lift Canal
W NEES AVE
13TH ST
AVENUE 7 1 2
Firebaugh
N FAIRFAX AVE
COUNTY HWY J1
Fresno Slough
Mendota
S RUSSELL AVE
CALIFORNIA AVE
Panoche Creek
S FAIRFAX AVE
165
33
152
5
180
N 0 2 4 8
Miles
California
Detail
Calaveras
Tuolumne
Stanislaus
Mariposa
Merced
Clara
Madera
Project Location
San Benito
Fresno
Monterey
N 0 20
Miles
Project Vicinity
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2007 Biological Monitoring: San Joaquin River Water Quality Improvement Project Site Vicinity Map
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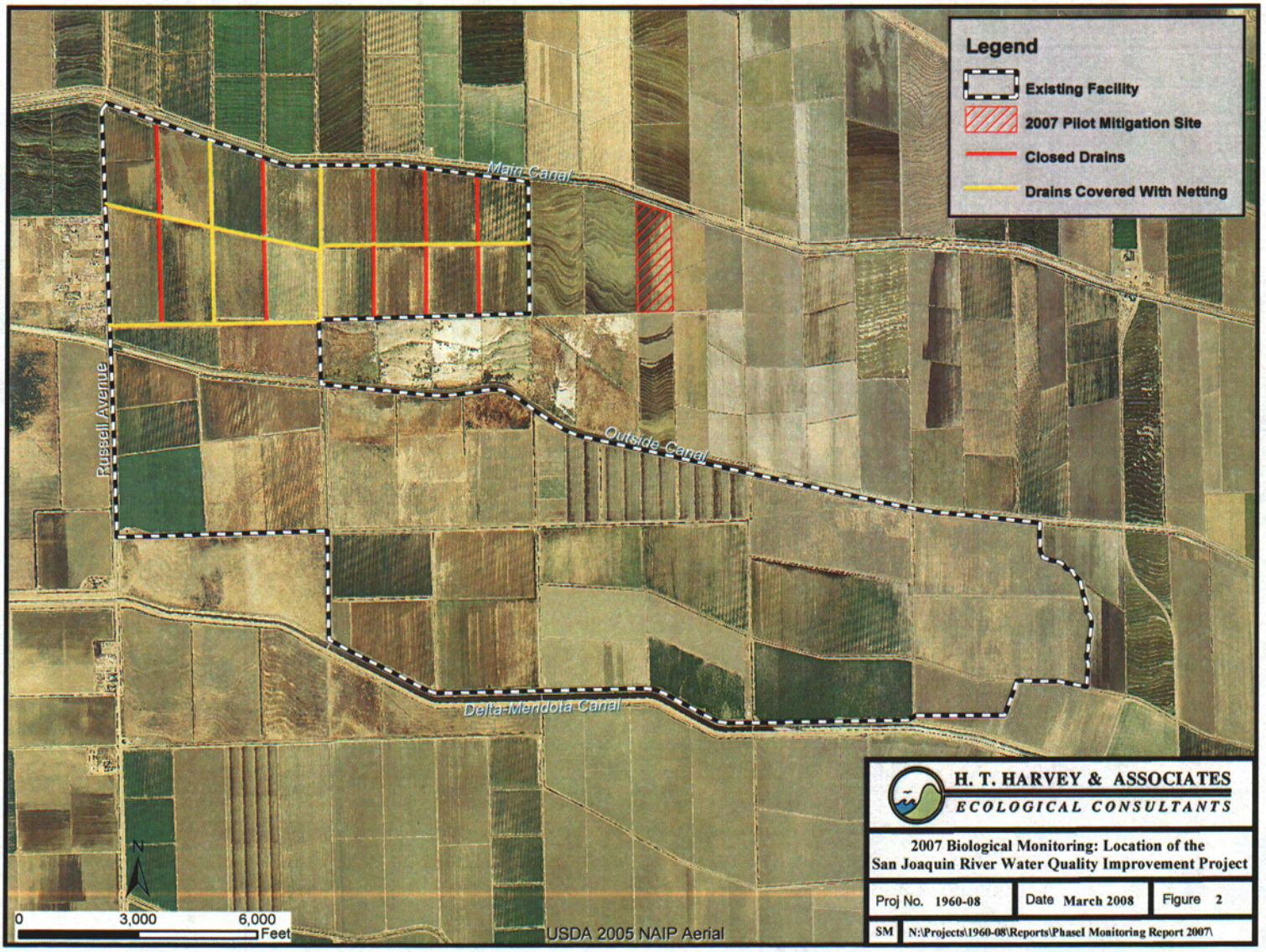
Legend
Existing Facility
2007 Pilot Mitigation Site
Closed Drains
Drains Covered With Netting
Main Canal
Outside Canal
Delta-Mendota Canal
Russell Avenue
N
0
3,000
6,000
Feet
USDA 2005 NAIP Aerial
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
2007 Biological Monitoring: Location of the
San Joaquin River Water Quality Improvement Project
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Date March 2008
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In Phase I, subsurface drainwater from the GDA is used to irrigate salt-tolerant crops on ideally situated land. Channels containing collected drainwater flow adjacent to this location, so water can easily be captured and placed on the land. Also, because this land is at the lowest elevation within the drainage area, collected water can be applied without excessive pumping costs.

Approximately 4000 acres have been purchased to date. Approximately 3873 acres of crops have been planted since 2001 and irrigated with water that otherwise would have been discharged into the San Joaquin River. Soil and water constituents at this project site will continue to be monitored to prevent irreversible soil changes and to protect groundwater from contamination.

In Phase II of the SJRIP, the application of saline water to lands developed in Phase I will continue. Subsurface drainage systems will be installed to leach the land and maintain a favorable salt balance. The water percolating below the root zone will be captured in the drainage system and passed on to more salt-tolerant crops to concentrate and decrease the volume of drainwater produced. Salt, selenium, and other constituents will be conveyed by water exiting the subsurface drainage systems. The final treatment phase of the SJRIP will remove the salt, selenium, and much of the other constituents, leaving water for beneficial uses, such as agriculture. The treatment system will be designed to incorporate into the reuse system. The remaining salt will be deposited into approved waste units that will result in additional reductions in salt and selenium discharges into the San Joaquin River and will maximize improvement in water-quality and meet reductions needed for future water-quality objectives.

Each phase of the facility will significantly reduce the amount of drainwater discharged to the San Joaquin River. Water sufficient for reuse on GDA agricultural lands could also be produced by the treatment systems. The project was designed to assist Grasslands Area Farmers in meeting applicable water-quality objectives for the 2007 calendar water year. The 2007 annual selenium-load limit, based on the current applicable total maximum monthly load, was 3545 lbs. In comparison, the load value for the 2001 water year was 5661 lbs. This reduction in load size required implementation of additional drainage management methods.

An Initial Study and Negative Declaration adopted 9 September 2000 by Panoche Drainage District, evaluated Phase I of the facility. The second and third phases of the facility were evaluated in the Grassland Bypass Project EIS/EIR, finalized 25 May 2001, and a Biological Opinion issued by the Service on 27 September 2001. Phase I is independent and does not exclude the consideration of alternatives to the larger project or project site. Even if the In-Valley Treatment/Drainage Reuse Project progress were to halt at Phase I, the drainage management alone would be valuable. In addition, the proposed cropping patterns are reversible should later phases of the project not be implemented.

Pilot Mitigation Site

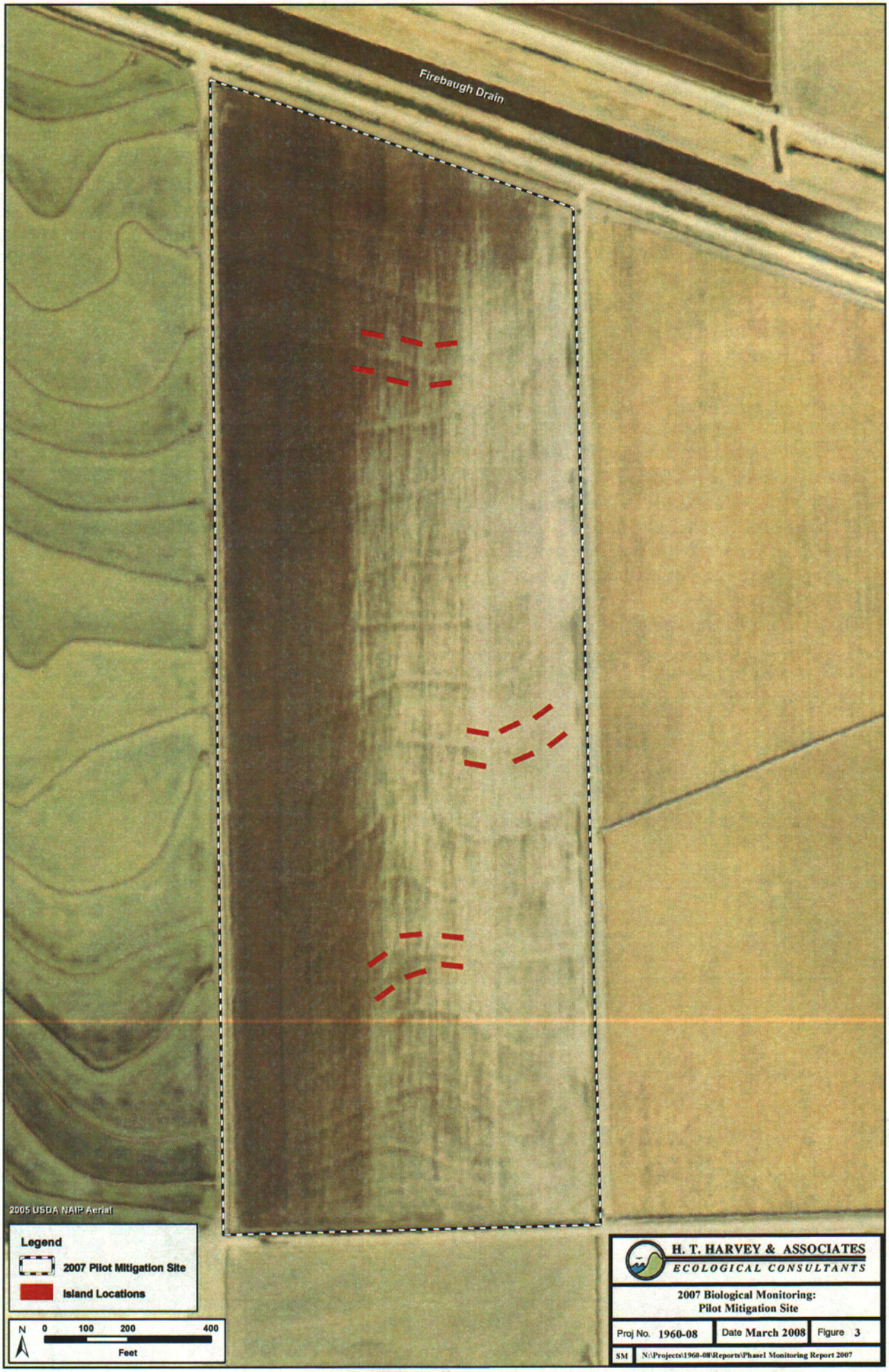
The Negative Declaration for SJRIP adopted in September 2000 included provisions for wildlife monitoring capable of assessing project-related impacts to wildlife. Provisions were also included for appropriate mitigation measures to be adopted if the monitoring program detected negative project-related impacts.

Based on waterborne and egg-selenium levels at the existing project site, lethal and sublethal effects on waterbirds breeding at the proposed project site are probable. Water samples from the sources of drainwater used to irrigate the existing project site ranged from 43 to 761-ppb selenium from 2003 to 2005 (Panoche Drainage District data). Such levels are well above the level of waterborne selenium (32-ppb) associated with a high probability of reduced hatchability and increased probability of teratogenesis (CH2M-Hill et al. 1993). Egg-selenium monitoring at the existing project site has found elevated egg-selenium levels in both recurvirostrids and killdeer. Egg-selenium levels in both groups have been higher than in similar sets of reference eggs collected from the project vicinity. Annual geometric mean, egg-selenium levels from recurvirostrid eggs have varied, but from 2003 to 2006, most means were also above the level (18-ppm) associated with an increased probability of reduced hatchability and teratogenesis.

Beginning in 2006, 3 mitigation measures were implemented to reduce impacts to nesting shorebirds. The first measure consisted of dredging the bottom of open drains that had been consistently used by shorebirds to eliminate potential feeding and nesting substrates. The next measure consisted of Panoche Drainage district personnel discharging cracker shells to discourage shorebird use where shorebird nesting had been concentrated in the past. These hazers patrolled the project site throughout the day to discourage breeding birds from establishing nests at the project site. The third measure consisted of enhancing habitat for nesting shorebirds outside the project site at a site with clean (non-seleniferous) water.

These measures were continued and enhanced in 2007. Several drains in the northern portion of the project site (Sections 2 and 3) where killdeer and recurvirostrid nesting had been concentrated in recent years were filled, and drains that could not be filled were covered with netting to prevent bird use (Figure 2).

As in 2006, breeding habitat comprising 50 acres of cultivated rice was created for shorebirds as a pilot mitigation site in 2007. Eighteen islands approximately 40 ft long and 7 ft wide were constructed within the 50-acre site irrigated with clean water (Figures 2 and 3). The islands were constructed to enhance the attractiveness and utility of the existing rice field for shorebirds by providing nesting habitat.



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2007 Biological Monitoring:
Pilot Mitigation Site

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MATERIALS AND METHODS

BIRD CENSUSES

An ornithologist from H. T. Harvey & Associates monitored bird use at the project site on 6 occasions from 21 April to 14 June 2007. Censuses were completed by driving the perimeter roads of each field. Birds were identified and counted using 10X binoculars and a 20-60X spotting scope mounted on a tripod. Censuses were conducted to determine species composition and relative abundance of bird species on the project site during the breeding season.

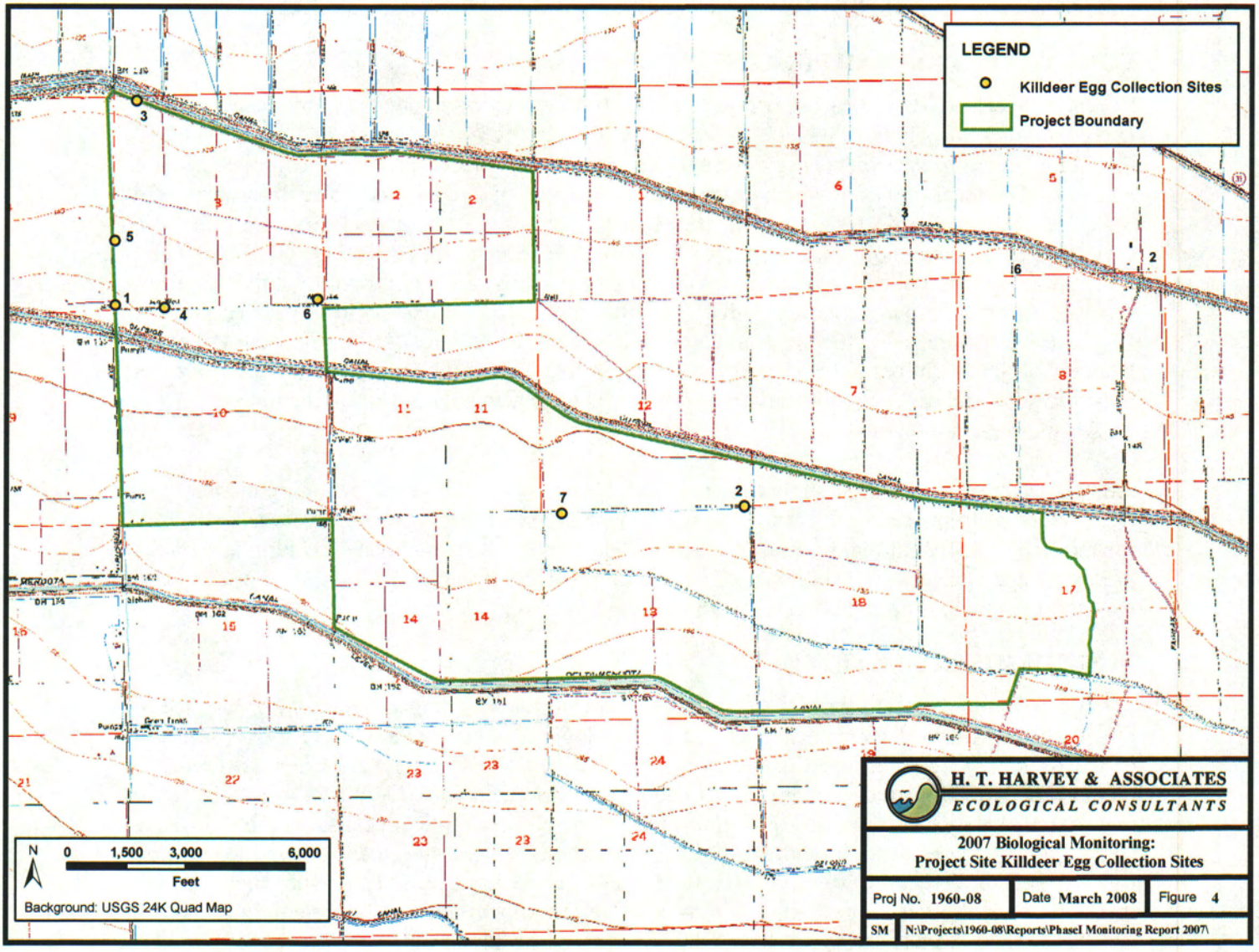
EGG COLLECTION AND PROCESSING

Seven killdeer (*Charadrius vociferus*) eggs, 16 recurvirostrid eggs (American avocets [*Recurvirostra americana*] or black-necked stilts [*Himantopus mexicanus*]) and 11 red-winged blackbird (*Agelaius phoeniceus*) eggs were collected from the project site for selenium and boron analysis. The locations from which killdeer, recurvirostrid, and red-winged blackbird eggs were collected from the project site are illustrated in Figures 4, 5, and 6; respectively. Scientific collecting permits were obtained from the California Department of Fish and Game (CDFG) and the Service for the collection of bird eggs on the site. One egg was randomly collected from separate, full-clutch (4 eggs) nests. Three additional sets of 15 reference killdeer eggs (Figure 7), 10 recurvirostrid eggs (Figure 8), and 11 red-winged blackbird eggs (Figure 9) were collected from the project vicinity to provide reference data on regional selenium and boron concentrations outside the project area. Five American avocets eggs were also collected from the mitigation site for selenium and boron analysis.

All eggs were labeled with a permanent marker. All of the egg contents, including membranes, were removed from the shell and transferred to 1 oz Dynalon jars. The embryo was examined for morphological abnormalities, and the stage of incubation was established using photographs of known-age embryos. The embryo was also examined to determine if it was alive or dead and was photographed. The egg contents were stored by freezing (32°F).

EGG CHEMISTRY ANALYSIS

All egg contents collected by H. T. Harvey & Associates were shipped overnight on dry ice to the Oscar E. Olson Biochemical Laboratory at South Dakota State University. Selenium concentrations were determined using the Association of Official Analytical Chemists (AOAC) method 996.16. Boron levels were determined by a nitric acid/peroxide digest in a microwave oven and quantitation by an inductively coupled plasma optical emission spectrometer (ICPOES). All egg-selenium and egg-boron concentrations were presented as parts per million (ppm) based on dry tissue weight (dry weight). For quality control, selected sub-samples were divided into 2 aliquots. The duplicate was spiked with known amounts of selenium or boron, and the samples were tested to determine the accuracy of the analysis.


LEGEND
Killdeer Egg Collection Sites
Project Boundary
N
0
1,500
3,000
6,000
Feet
Background: USGS 24K Quad Map
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2007 Biological Monitoring:
Project Site Killdeer Egg Collection Sites
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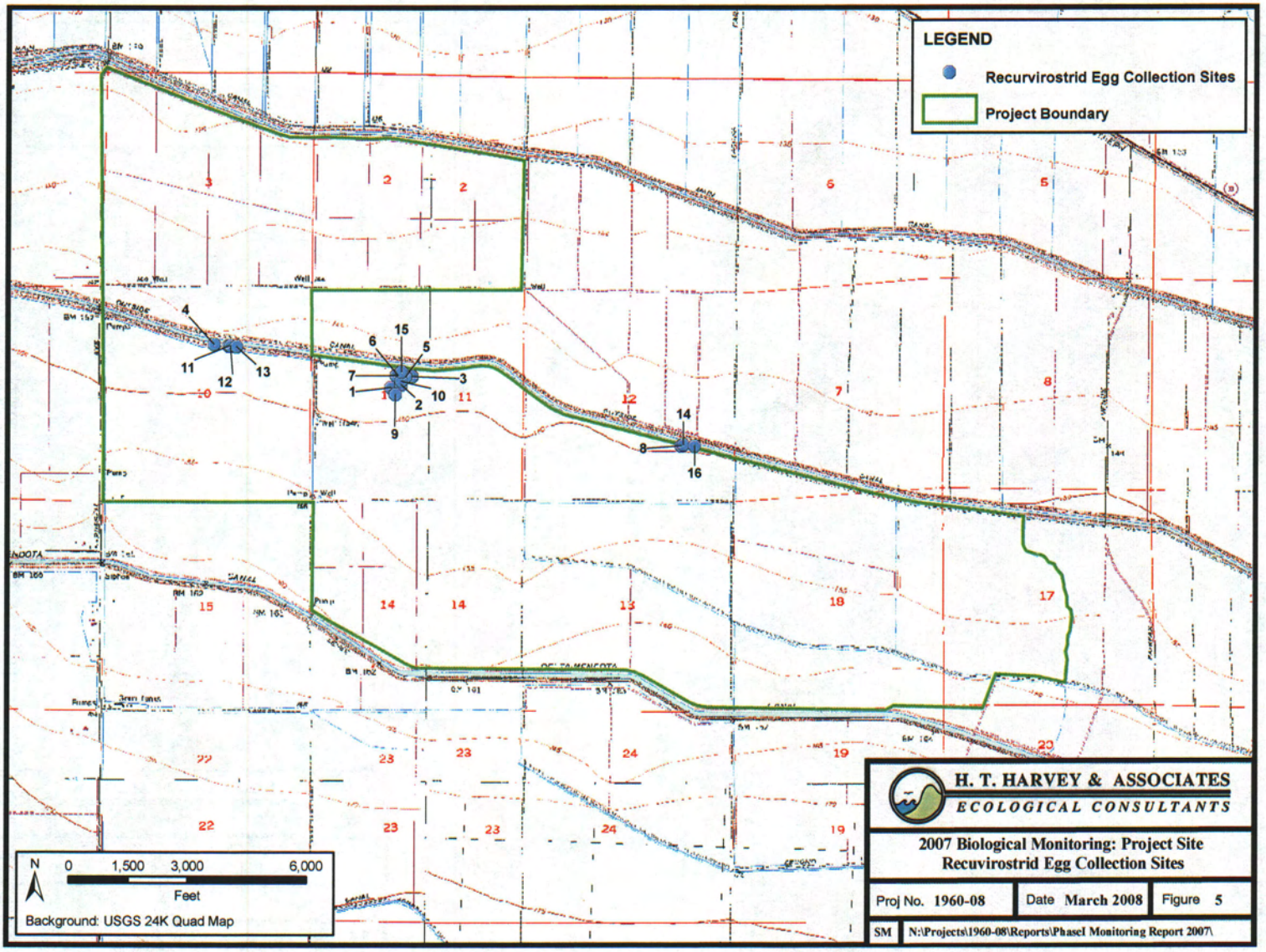
LEGEND
Recurvirostrid Egg Collection Sites
Project Boundary
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Background: USGS 24K Quad Map
H. T. HARVEY & ASSOCIATES
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2007 Biological Monitoring: Project Site
Recuvirostrid Egg Collection Sites
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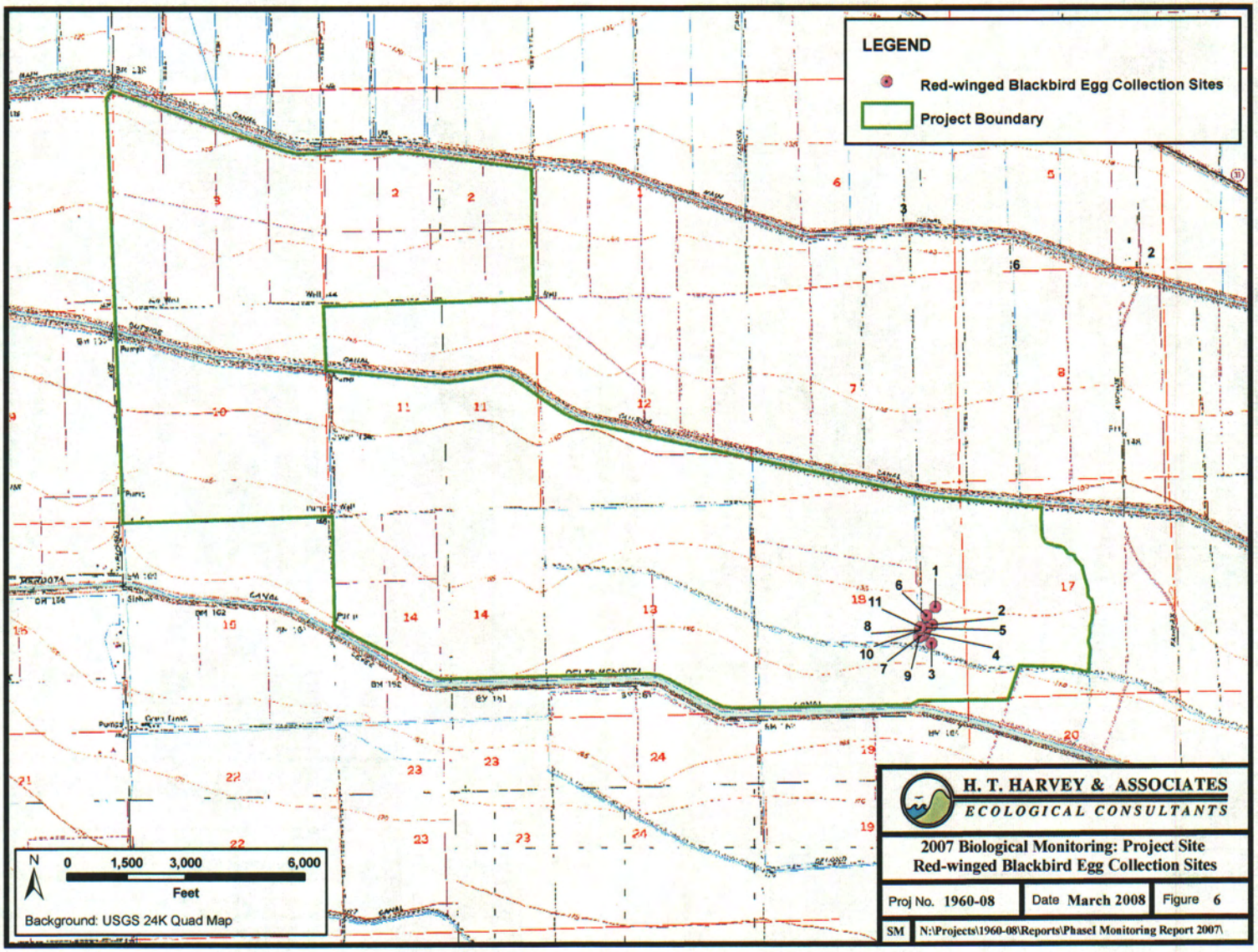
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Red-winged Blackbird Egg Collection Sites
Project Boundary
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2007 Biological Monitoring: Project Site
Red-winged Blackbird Egg Collection Sites
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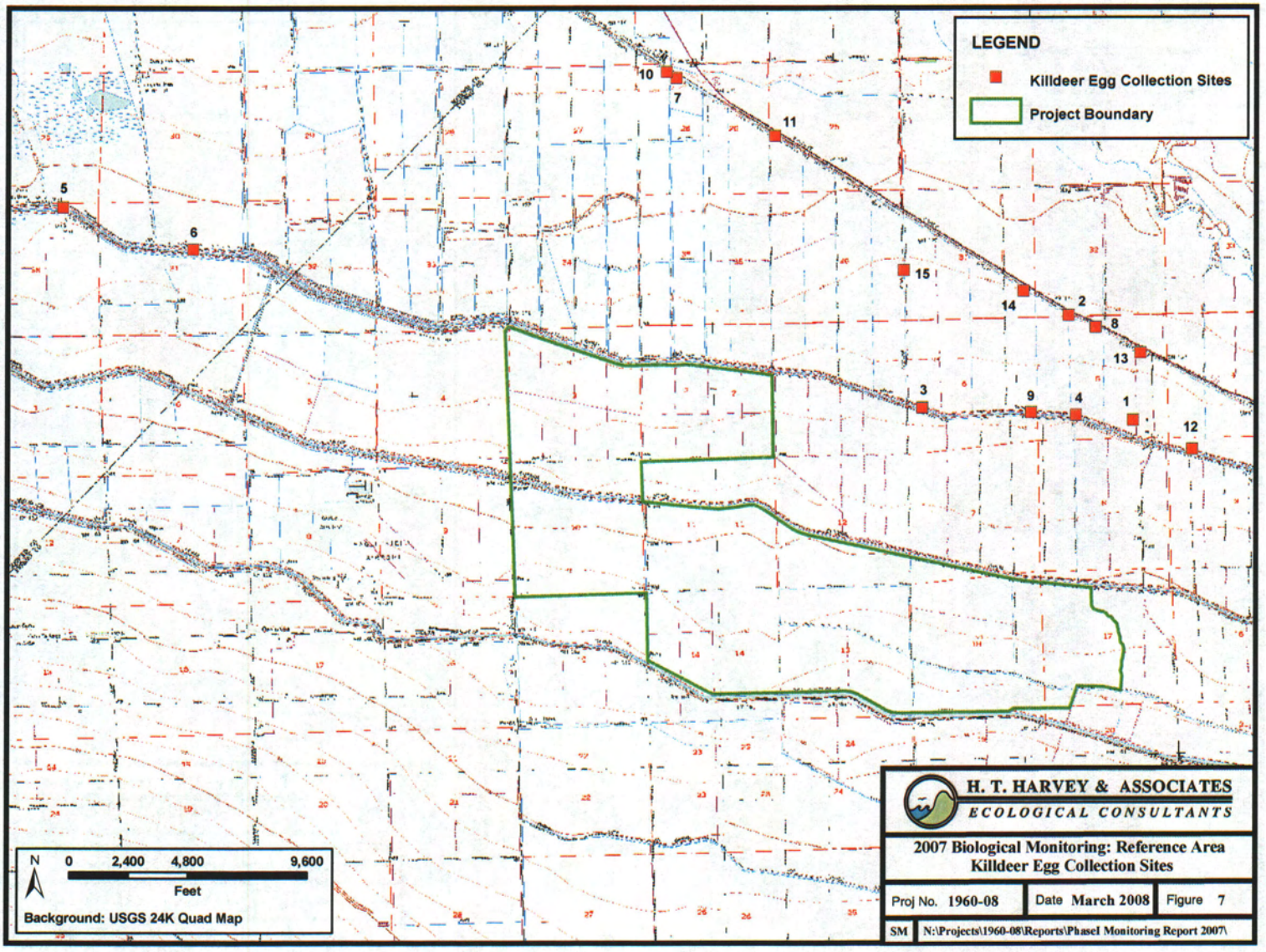
LEGEND
Killdeer Egg Collection Sites
Project Boundary
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2,400
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Background: USGS 24K Quad Map
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2007 Biological Monitoring: Reference Area
Killdeer Egg Collection Sites
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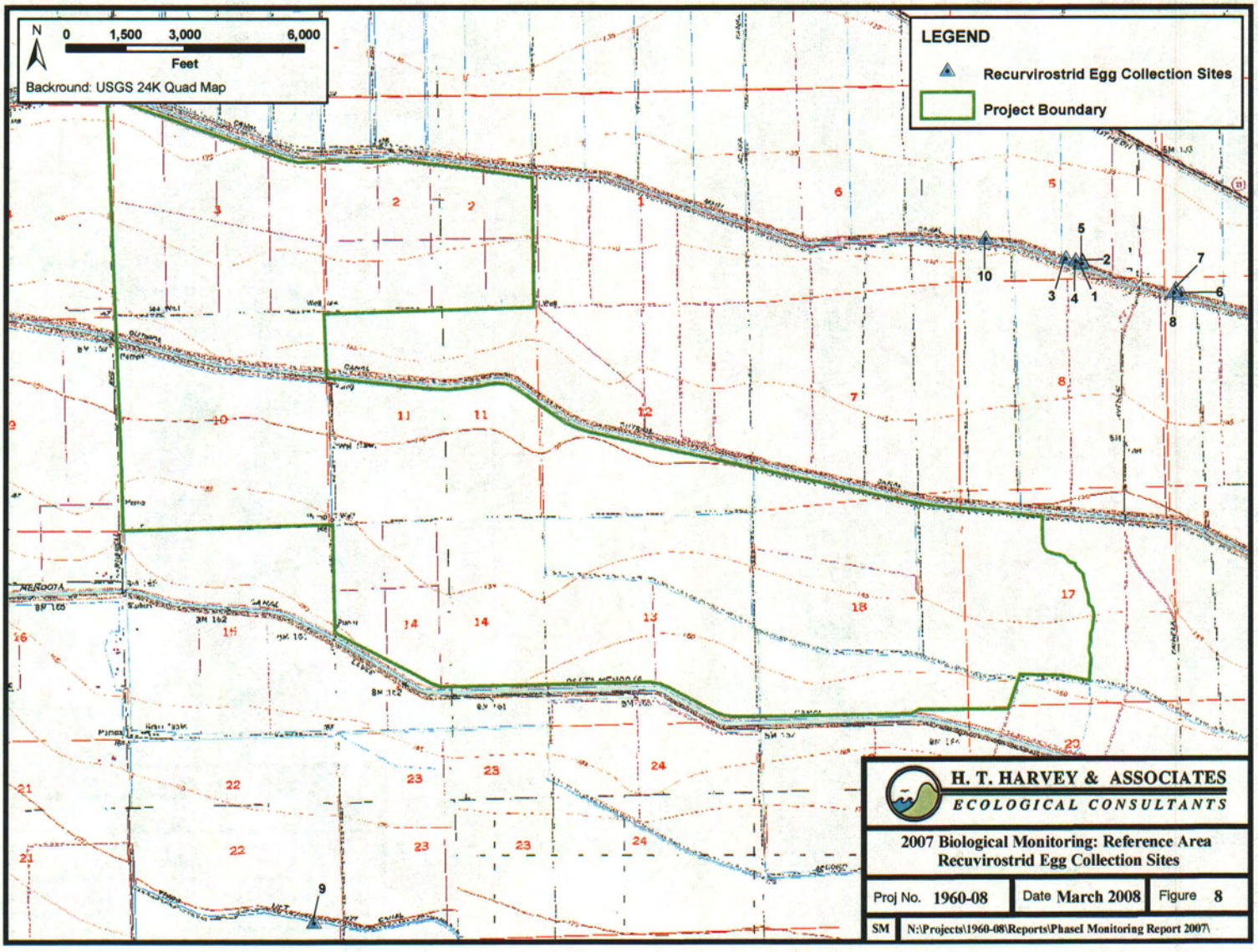
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Backround: USGS 24K Quad Map
LEGEND
Recurvirostrid Egg Collection Sites
Project Boundary
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H. T. HARVEY & ASSOCIATES
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2007 Biological Monitoring: Reference Area
Recuvirostrid Egg Collection Sites
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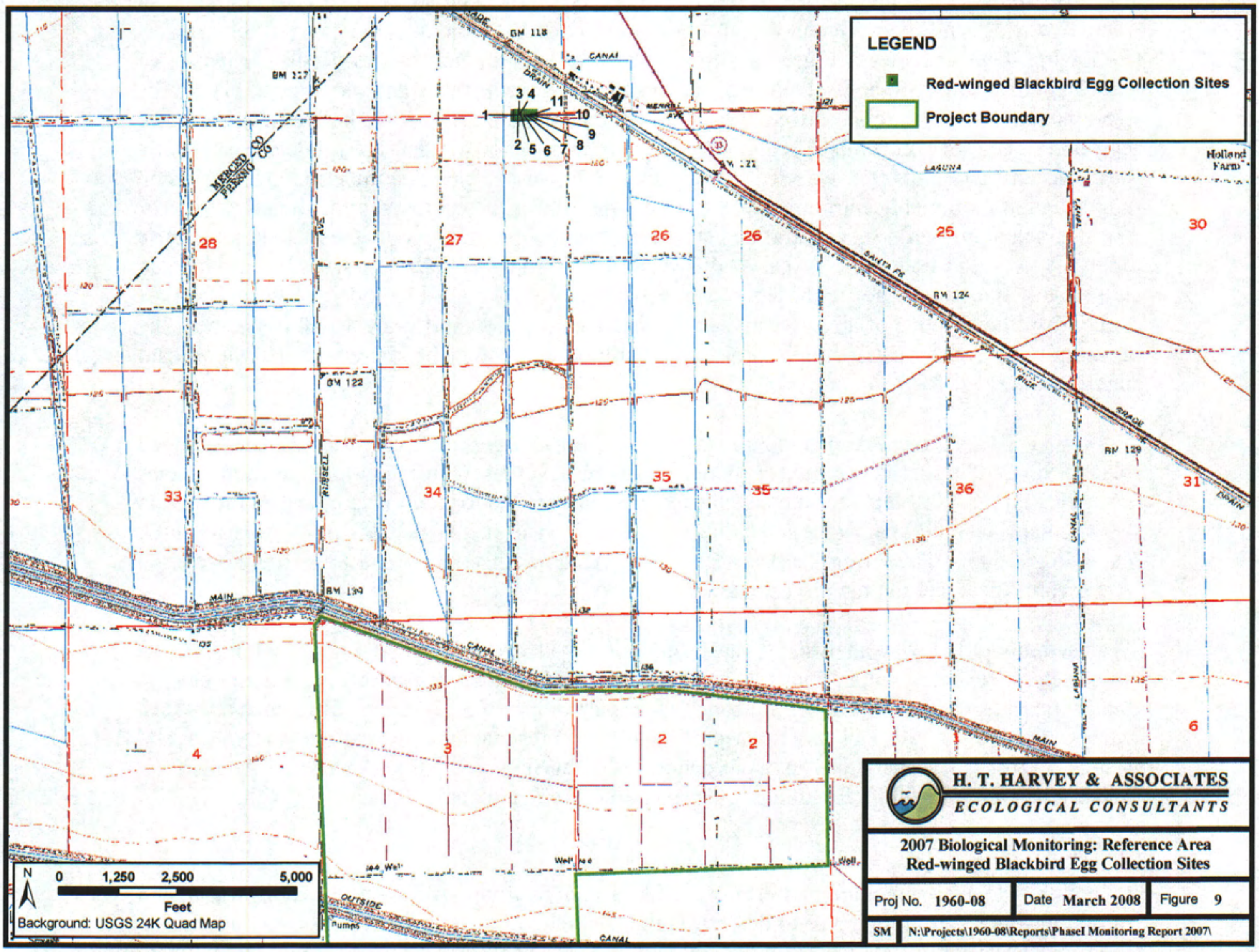

2007 Biological Monitoring: Reference Area Red-winged Blackbird Egg Collection Sites

Proj No. 1960-08 | Date March 2008 | Figure 9

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Data were evaluated for normality with the Kolmogorov-Smirnov test and for homoscedasticity with Levene's test. Egg-selenium and egg-boron concentrations for all avian groups were Log_{10} transformed (Log_{10}[egg selenium or boron concentration +1]) to improve the fit to parametric assumptions of homoscedasticity and normality. Although log-transformations improved the fit to parametric assumptions, egg-selenium data for recurvirostrids and red-winged blackbirds were marginally heteroscedastic ($P = 0.01$ to 0.02) and highly heteroscedastic for killdeer ($P < 0.001$). We used model II 2-way analysis of variance (ANOVA) to test for the effect of location (project site, reference site) and year (2002 through 2007) on egg-selenium concentrations in recurvirostrids and egg-selenium and egg-boron concentrations in red-winged blackbirds. Following these analyses, we used a Kruskal-Wallis nonparametric test to verify the results of the effect of location on egg-selenium concentration in recurvirostrids and red-winged blackbirds (results qualitatively similar between parametric and nonparametric tests in both cases). Because egg-boron data for recurvirostrids and egg-selenium and egg-boron data for killdeer were highly heteroscedastic ($P \leq 0.001$), we used the Kruskal-Wallis test to examine the effect of location on egg-selenium/boron concentration and a second Kruskal-Wallis test to examine the effect of year on egg-selenium/boron concentration in these species groups. For these non-parametric analyses, we used both the Kruskal-Wallis ANOVA by ranks test (H test statistic) and median test (χ^2 test statistic). Prior to these nonparametric analyses, we used a model II 2-way ANOVA to confirm the absence of an interactive effect between location and year. In all cases, with the exception of recurvirostrids egg-boron concentration ($P < 0.001$), there was no significant interaction ($P > 0.10$).

We used a 1-way ANOVA to compare sites in 2007 for killdeer, recurvirostrids, and red-winged blackbird. Additionally, we used a model II 3-way ANOVA with location, year, and species (American avocet or black-necked stilt) as independent factors to examine a potential interaction between species and year on egg-selenium concentration in recurvirostrids from 2003 to 2007, excluding 2005. Data from 2005 was not included in this model because there were no American avocet nests at the project site that year.

We used model II 1-way analysis of variance (ANOVA) to test for the effect of location (project site, reference site, mitigation site) on egg-selenium and egg-boron concentrations in recurvirostrids. We also used Bonferroni's multiple comparison to test for differences between each pair of sites. Calculated descriptive statistics presented below include the mean and standard error (SE). All analyses were conducted with Statistica 6.0 and SYSTAT version 11. We used an α level of 0.05 for all analyses, except where noted above.

NEST FATE

In addition to egg-selenium monitoring, killdeer and recurvirostrid nests on the project and mitigation sites were monitored to determine the nest fate. Active nests were located by driving the project site while looking for adult killdeer and recurvirostrids. Once located, adults were monitored with a spotting scope or binoculars until a nest location could be determined. Nests were located at the mitigation site by walking searches of the levees and the islands. Nest locations were marked using a GPS unit (Garmin GPS 12 CX, 12 Channel, Olathe, KS). Nest location, stratum, date, number of eggs present, nest status, nest/clutch fate, and nest agent were recorded for each nest encountered. The nests were monitored to completion and nest fates were recorded. A completed nest was one that was empty (chicks presumed to have hatched or a predator took the eggs), chicks were present, the nest was abandoned, or the nest was destroyed.

PILOT MITIGATION SITE WATER QUALITY

Water samples were collected at the inlet to the mitigation site on 8 May 2007 The samples were sent to the BSK Analytical Laboratories in Fresno, California to be analyzed for electrical conductivity and selenium and boron content.

RESULTS

BIRD CENSUSES

In the Phase I area, 41 avian species were observed between 13 April and 19 June 2007 (Table 1). Avian numbers were highest in May, when white-faced ibis (*Plegadis chihi*) and migrating shorebirds such as whimbrels (*Numenius phaeopus*) were present (Table 1). The red-winged blackbird was the most numerous avian species observed on the project site. Seventeen species were either observed nesting, or were suspected of nesting, on the site based on observations of courtship behavior or young. Total bird numbers declined in June as fewer migrants were detected.

EGG COLLECTION AND PROCESSING

Thirty-four eggs, comprising 7 killdeer, 16 recurvirostrid eggs, and 11 red-winged blackbird eggs were collected from the project site. One killdeer embryo was 17 days old and was alive and in normal condition. Another 2 killdeer embryos were alive, but too young (3 to 6 days old) to determine their condition. The remaining 4 killdeer embryos were less than 3 days old (Table 2). One recurvirostrid egg contained a live, normal, greater than 12-day-old embryo. The 15 remaining recurvirostrid embryos were too young (less than 9 days old) to determine the embryo status, though 12 were old enough (3 days old or older) to determine that they were alive (Table 3). All 11 of the red-winged blackbirds embryos were too young to determine the embryo status, though 9 were old enough to determine that they were alive (Table 4).

Thirty-six eggs (15 killdeer, 10 recurvirostrid and 11 red-winged blackbird) were collected from the vicinity of the project site. Two killdeer embryo from the reference area were at least 15 days old and were alive and in normal condition. The remaining 13 killdeer embryos were too young to determine the embryo status, though 6 were old enough to determine that they were alive (Table 5). Two of the recurvirostrid eggs contained a live, normal, at least 9-day-old embryo. The 8 remaining recurvirostrid embryos were too young to determine the embryo status, though 6 were old enough to determine that they were alive (Table 6). All 11 of the red-winged blackbirds were too undeveloped for their status to be assessed, though 6 were developed enough (they contained feathered embryos), to determine that they were alive (Table 7).

Five American avocet eggs were collected from the mitigation site. Four of the American avocet eggs were more than 9 days old, and were alive and in normal condition. The remaining American avocet embryo was too young to determine the embryo status, but was old enough to determine it was alive (Table 8).

Table 1. Avian census results at the San Joaquin River Water Quality Improvement Project.

	2007					
Species	**April 13**	**May 01**	**May 16**	**May 30**	**June 06**	**June 19**
Great blue heron	2	1	2	1		
Great egret	6	11	3	1	2	1
Snowy egret	14	22	16	18	21	14
Cattle egret	16	21	32	8	7	
Black-crowned night heron	1		13	7		6
White-faced ibis	7	93	63	126	41	3
Mallard	6	2	7	9	2	
Northern pintail	2					
Cinnamon teal	4	6	5			
Northern harrier	1	1		2	2	
Swainson's hawk		2	4	3	31	1
Red-tailed hawk	5	2	4	2	2	5
* American kestrel	1	1	3	2	2	1
* Killdeer	16	18	24	25	21	18
* Black-necked stilt	12	13	16	17	9	7
* American avocet	14	19	22	15	9	6
Greater yellowlegs			4			
Whimbrel	116	137	78			
Long-billed curlew	11		7	9	10	8
Black tern				2	1	1
* Mourning dove	38	25	21	16	4	6
Barn owl			1			
* Burrowing owl	9	10	8	24	16	9
* Western kingbird	22	26	21	26	28	24
* Loggerhead shrike	2	4	4	6	3	3
Common raven	6	18	11	48	59	26
* Horned lark	13	10	8	6	2	
Northern rough-winged swallow	5	5	4	2		
Barn swallow	6	8	9	11	4	1
Cliff swallow	11	14	18	11	5	5
American pipit	108	41	3			
Savannah sparrow	51	25	2			
* Song sparrow	16	21	24	29	34	29
* Blue grosbeak			3	2	3	1
* Red-winged blackbird	221	317	363	425	251	219
Tricolored blackbird	18	22	19	7		48
* Western meadowlark	24	38	31	26	11	6
* Brewer's blackbird	31	38	121	62	41	17
* Brown headed cowbird	11	22	18	16	31	17
* House finch	46	24	26	22	9	11
* House sparrow	13	14	19	10	8	6
Total	**885**	**1031**	**1037**	**996**	**669**	**499**

***Species for which evidence of nesting was observed this year.**

Table 2. Project site killdeer egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	K-01	Killdeer	May 16	U	U	1	11.2	1.0492	
02	K-02	Killdeer	May 16	L	N	17	16.4	1.2148	
03	K-03	Killdeer	May 16	U	U	1	10.6	1.0253	
04	K-04	Killdeer	May 30	U	U	1	33.6	1.5263	
05	K-05	Killdeer	June 14	L	U	1-3	6.95	0.8420	
06	K-06	Killdeer	June 19	L	U	3-6	27.9	1.4456	
07	K-07	Killdeer	June 26	U	U	1	12.7	1.1038	
Arith/Geo Mean							17.1	1.1724	***14.9***
SD							9.9	0.2424	***1.7***
SE								0.1084	***1.3***
95% CI								0.9600	***9.1***
								1.3849	***24.3***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown

Table 3. Project site recurvirostrid egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	A-01	American avocet	May 9	L	U	6	18.4	1.2648	
02	A-02	American avocet	May 9	U	U	1	31.3	1.4955	
03	A-03	American avocet	May 9	L	U	3-6	35.2	1.5465	
04	A-05	American avocet	May 16	L	U	6-9	40.1	1.6031	
05	A-06	American avocet	May 16	L	U	1-3	28.6	1.4564	
06	A-04	American avocet	May 16	L	U	6-9	21.8	1.3385	
07	S-01	Black-necked stilt	May 16	U	U	1	12.3	1.0899	
08	S-02	Black-necked stilt	May 25	U	U	1	9.57	0.9809	
09	A-07	American avocet	May 30	L	U	6	14.0	1.1461	
10	A-08	American avocet	June 1	L	U	1-3	14.9	1.1732	
11	S-03	Black-necked stilt	June 6	L	U	1-3	17.2	1.2355	
12	A-09	American avocet	June 14	L	U	3-6	20.2	1.3054	
13	S-04	Black-necked stilt	June 14	L	U	1-3	10.6	1.0253	
14	S-05	Black-necked stilt	June 14	L	U	6	4.75	0.6767	
15	S-06	Black-necked stilt	June 14	L	N	12-15	8.89	0.9489	
16	A-10	American avocet	June 19	L	U	6	18.9	1.2765	
Arith/**Geo Mean**							19.2	1.2227	***16.7***
SD							10.0	0.2450	***1.8***
SE								0.1096	***1.3***
95% CI								1.0080	***10.2***
								1.4374	***27.4***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 4. Project site red-winged blackbird egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Red-winged blackbird	May 25	L	U	3-9	7.51	0.8756	
02	Red-winged blackbird	May 25	L	U	3-9	6.69	0.8254	
03	Red-winged blackbird	May 25	L	U	3-9	7.36	0.8669	
04	Red-winged blackbird	May 25	L	U	3-9	6.92	0.8401	
05	Red-winged blackbird	May 25	L	U	3-9	7.92	0.8987	
06	Red-winged blackbird	May 25	L	U	3-9	6.86	0.8363	
07	Red-winged blackbird	May 25	L	U	1-3	6.45	0.8096	
08	Red-winged blackbird	May 25	U	U	1	12.1	1.0828	
09	Red-winged blackbird	May 25	U	U	1	8.59	0.9340	
10	Red-winged blackbird	May 25	L	U	1-3	9.08	0.9581	
11	Red-winged blackbird	May 25	L	U	1-3	9.13	0.9605	
Arith/Geo Mean						8.1	0.8989	*7.9*
SD						1.6	0.0804	*1.2*
SE							0.0360	*1.1*
95% CI							0.8284	*6.7*
							0.9694	*9.3*

[a] L= Live, D= Dead, U= Unknown, [b] N= Normal, A= Abnormal, U= Unknown.

Table 5. Reference area killdeer egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Killdeer	May 9	L	U	1-3	3.23	0.5092	
02	Killdeer	May 9	L	U	1-3	4.30	0.6335	
03	Killdeer	May 16	U	U	1	5.56	0.7451	
04	Killdeer	May 16	L	U	3-6	3.60	0.5563	
05	Killdeer	May 23	L	N	15	6.57	0.8176	
06	Killdeer	June 14	U	U	1	3.36	0.5263	
07	Killdeer	June 14	L	U	1-3	3.65	0.5623	
08	Killdeer	June 14	U	U	1	2.18	0.3385	
09	Killdeer	June 14	U	U	1	4.71	0.6730	
10	Killdeer	June 26	U	U	1	3.98	0.5999	
11	Killdeer	June 26	L	N	20+	3.90	0.5911	
12	Killdeer	July 3	L	U	6	3.53	0.5478	
13	Killdeer	July 3	U	U	1	2.76	0.4409	
14	Killdeer	July 3	L	U	3-6	3.12	0.4942	
15	Killdeer	July 3	U	U	1	3.79	0.5786	
Arith/Geo Mean						3.88	0.5743	***3.8***
SD						1.1	0.1165	***1.3***
SE							0.0521	***1.1***
95% CI							0.4721	***3.0***
							0.6764	***4.7***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown

Table 6. Reference area recurvirostrid egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Black-necked stilt	May 9	L	U	1-3	7.72	0.8876	
02	Black-necked stilt	May 9	L	N	9	6.14	0.7882	
03	Black-necked stilt	May 9	L	U	6	6.86	0.8363	
04	Black-necked stilt	May 23	U	U	1	8.80	0.9445	
05	American avocet	May 23	U	U	1	18.9	1.2765	
06	American avocet	May 23	L	U	1-3	10.0	1.0000	
07	American avocet	May 30	L	N	12	11.9	1.0755	
08	Black-necked stilt	June 1	L	U	1-3	5.46	0.7372	
09	American avocet	June 6	L	U	1-3	15.8	1.1987	
10	American avocet	June 6	L	U	1-3	12.8	1.1072	
Arith/Geo Mean						10.4	0.9852	***9.7***
SD						4.4	0.1787	***1.5***
SE							0.0799	***1.2***
95% CI							0.8285	***6.7***
							1.1418	***13.9***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 7. Reference area red-winged blackbird egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Red-winged blackbird	June 14	U	U	1	4.68	0.6702	
02	Red-winged blackbird	June 14	L	U	6-9	4.48	0.6513	
03	Red-winged blackbird	June 14	U	U	1	3.52	0.5465	
04	Red-winged blackbird	June 14	U	U	1	3.34	0.5237	
05	Red-winged blackbird	June 14	L	U	1-3	3.51	0.5453	
06	Red-winged blackbird	June 14	L	U	1-3	2.70	0.4314	
07	Red-winged blackbird	June 14	U	U	1	3.84	0.5843	
08	Red-winged blackbird	June 14	L	U	1-3	3.44	0.5366	
09	Red-winged blackbird	June 14	U	U	1	3.33	0.5224	
10	Red-winged blackbird	June 14	L	U	1-3	3.11	0.4928	
11	Red-winged blackbird	June 14	L	U	6-9	3.89	0.5899	
Arith/Geo Mean						3.6	0.5540	*3.6*
SD						0.6	0.0681	*1.2*
SE							0.0304	*1.1*
95% CI							0.4944	*3.1*
							0.6137	*4.1*

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown

Table 8. Mitigation Site recurvirostrid egg-selenium concentrations at the San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2007	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	MA-01	American avocet	May 18	L	U	6-9	33.4	1.5237	
02	MA-02	American avocet	May 18	L	N	15-16	25.0	1.3979	
03	MA-03	American avocet	May 18	L	N	12-15	10.7	1.0294	
04	MA-04	American avocet	May 18	L	N	12	17.5	1.2430	
05	MA-06	American avocet	May 18	L	N	9	17.7	1.2480	
Arith/Geo Mean							20.9	1.2884	***19.4***
SD							8.6	0.1859	***1.5***
SE								0.0831	***1.2***
95% CI								1.1255	***13.4***
								1.4513	***28.3***

[a]) L= Live. D= Dead. U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

EGG CHEMISTRY ANALYSIS

Egg-Selenium Data Analysis Between Sites

Egg-selenium concentrations were significantly higher in eggs collected from the project site relative to eggs collected from the reference area in 2007 for all three species groups (Table 9).

Table 9. Geometric mean egg-selenium concentrations from the San Joaquin River Water Quality Improvement Project.

Location	n	Geo. Mean Ppm se (dry wt)	Range
Killdeer			
Project site	7	14.9	6.95-33.6
Off-site reference sample	15	3.8	2.18-6.57
Significance difference ($F_{1,20}$ = 62.956, $P < 0.001$) between sites.			
Recurvirostrids			
Project Site	16	16.7	4.75-40.1
Off-site Reference Samples	10	9.7	5.46-18.9
Significance difference ($F_{1,24}$ = 7.017, $P = 0.014$) between sites.			
Red-winged blackbirds			
Project Site	11	7.9	6.45-12.1
Off-site Reference Samples	11	3.6	2.70-4.68
Significance difference ($F_{1,20}$ = 117.893, $P < 0.001$) between sites.			

Egg-Selenium Data Analysis Across Years

Egg-selenium concentrations in killdeer were 3.6 times greater at the project site (18.1 ± 1.3) than at the reference site (5.0 ± 0.3 ppm; $H = 92.700$, $P < 0.001$; $\chi^2 = 92.574$, df = 1, $P < 0.001$; Figure 10). For recurvirostrids, egg-selenium concentrations were 2.3 times greater at the project site (30.8 ± 2.3 ppm) relative to eggs collected from the reference area (13.6 ± 1.1 ppm; Table 10, Figure 11). Egg-selenium concentrations in red-winged blackbirds were 1.8 times greater at the project site (7.2 ± 0.3 ppm) compared to the reference site (4.1 ± 0.2 ppm; Table 10, Figure 12).

Killdeer egg-selenium concentration among years approached being statistically different (H = 11.050, P = 0.051; χ^2 = 9.987, df = 5, P = 0.076), but there was no significant site and year interaction (P = 0.166). There was a significant interaction between year and location in recurvirostrid egg-selenium concentrations, with a notable drop in selenium concentration at the project site relative to the reference site in 2004 and returning to these levels again in 2007 (Figure 11, Table 10). In red-winged blackbirds, there was a significant interaction between site and year, with greater differences between project and reference sites in 2006 and 2007 than earlier in the study (2003 and 2004, Table 10).

Figure 10. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for killdeer at the San Joaquin River Water Quality Improvement Project (2002 to 2007).

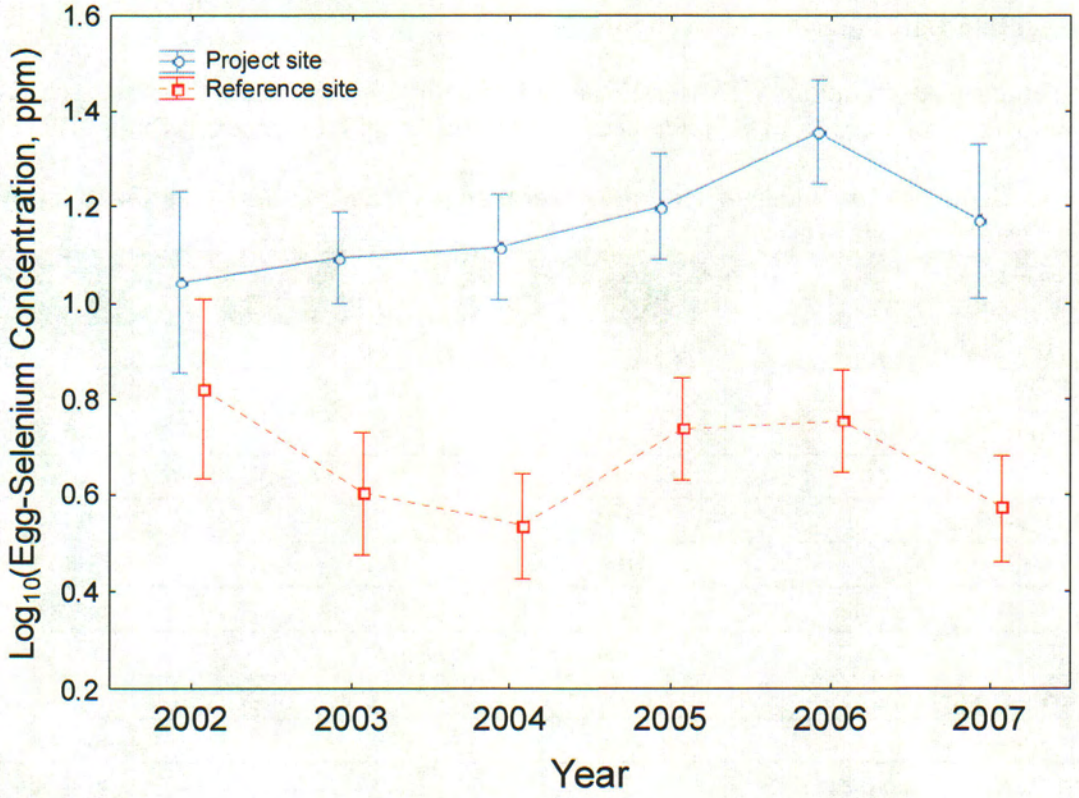


Table 10. Results of ANOVAs for effects of location and year on egg-selenium concentration in recurvirostrids, and egg-selenium and egg-boron concentrations in red-winged blackbirds at the San Joaquin River Water Quality Improvement Project (2003 to 2007).

Avian species group	Element	Factor	*F*	df	*P*
Recurvirostrids*	Selenium	site	48.324	1,143	<0.001
		year	6.971	4,143	<0.001
		site × year	1.742	4,143	0.144
Red-winged blackbird	Selenium	site	138.735	1,93	<0.001
		year	3.390	3,93	0.021
		site × year	7.030	9,93	<0.001
Red-winged blackbird	Boron	site	3.875	1,93	0.052
		year	11.040	3,93	<0.001
		site × year	18.624	9,93	<0.001

- *Egg-boron concentrations for recurvirostrids were analyzed using Kruskal-Wallis tests and are not presented on this table.
- The interaction between "year" and "site" was tested after the main effects for the 2 respective variables had been tested.

Figure 11. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for recurvirostrids at the San Joaquin River Water Quality Improvement Project (2003 to 2007).

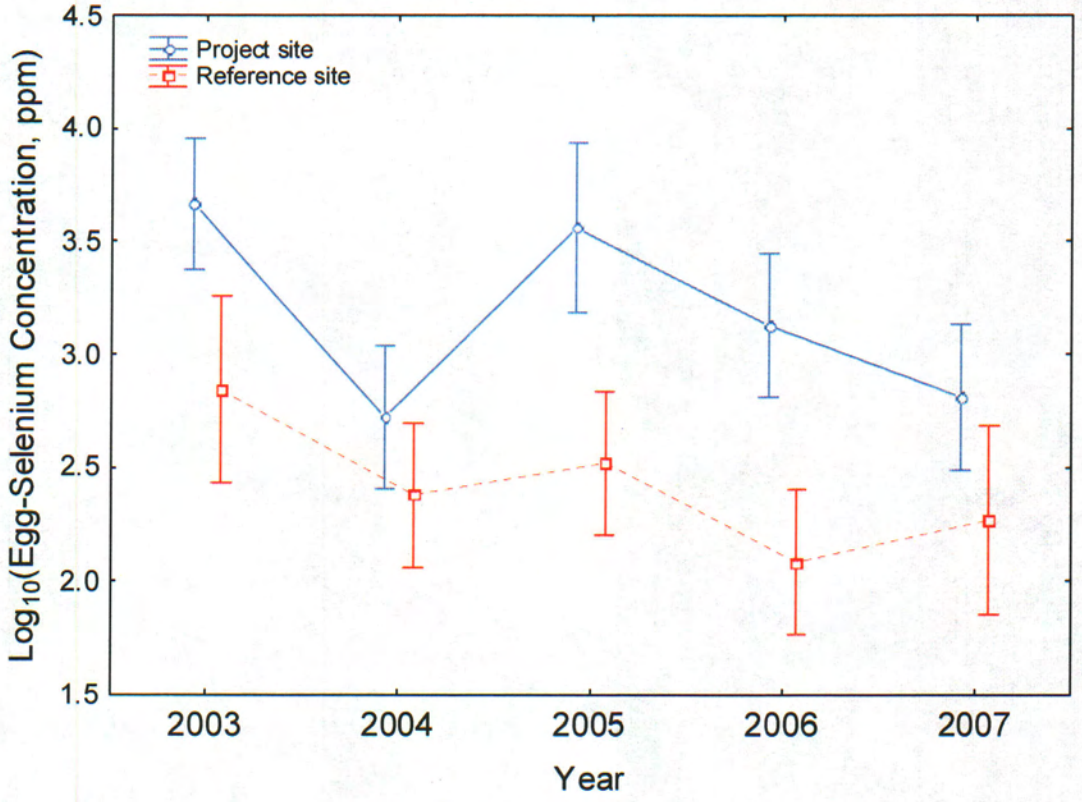
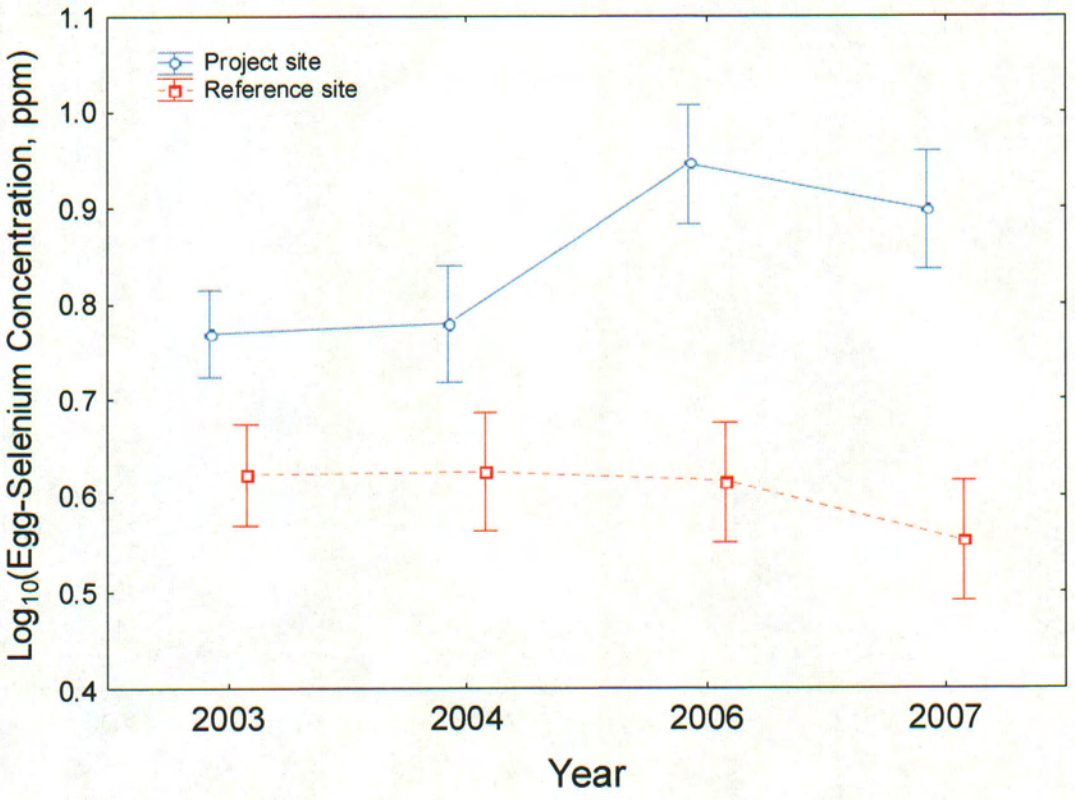


Figure 12. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for red-winged blackbirds at the San Joaquin River Water Quality Improvement Project (2003 to 2007).

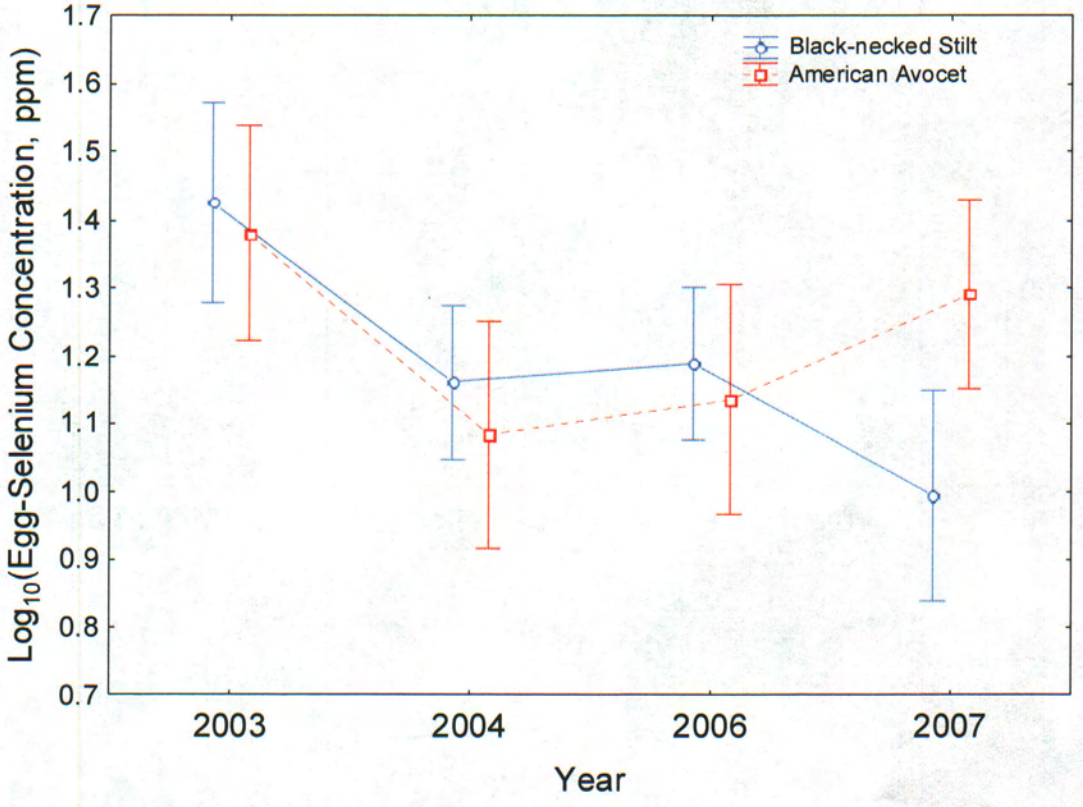


For recurvirostrids, mean egg-selenium concentrations were greater from the project site relative to the reference site, different among years, and different by species among years. The difference by species among sites approached significance, but was not significant (Table 11, Figure 13). There was no significant difference in mean egg-selenium between American avocets and black-necked stilts. American avocets had higher egg-selenium relative to black-necked stilts in 2007, but the difference was not significant (Figure 13).

Table 11. Results of 3-way ANOVA for effects of location, year, and species of recurvirostrid (American avocet and black-necked stilt) on egg-selenium concentration at the San Joaquin River Water Quality Improvement Project (2003 to 2007).

Factor	*F*	df	*P*
species	0.357	1107	0.553
site	27.617	1107	<0.001
year	6.369	3107	0.001
species × year	2.784	3107	0.044
species × site	3.790	1107	0.054
year × site	0.998	3107	0.397
species × year × site	2.001	3107	0.118

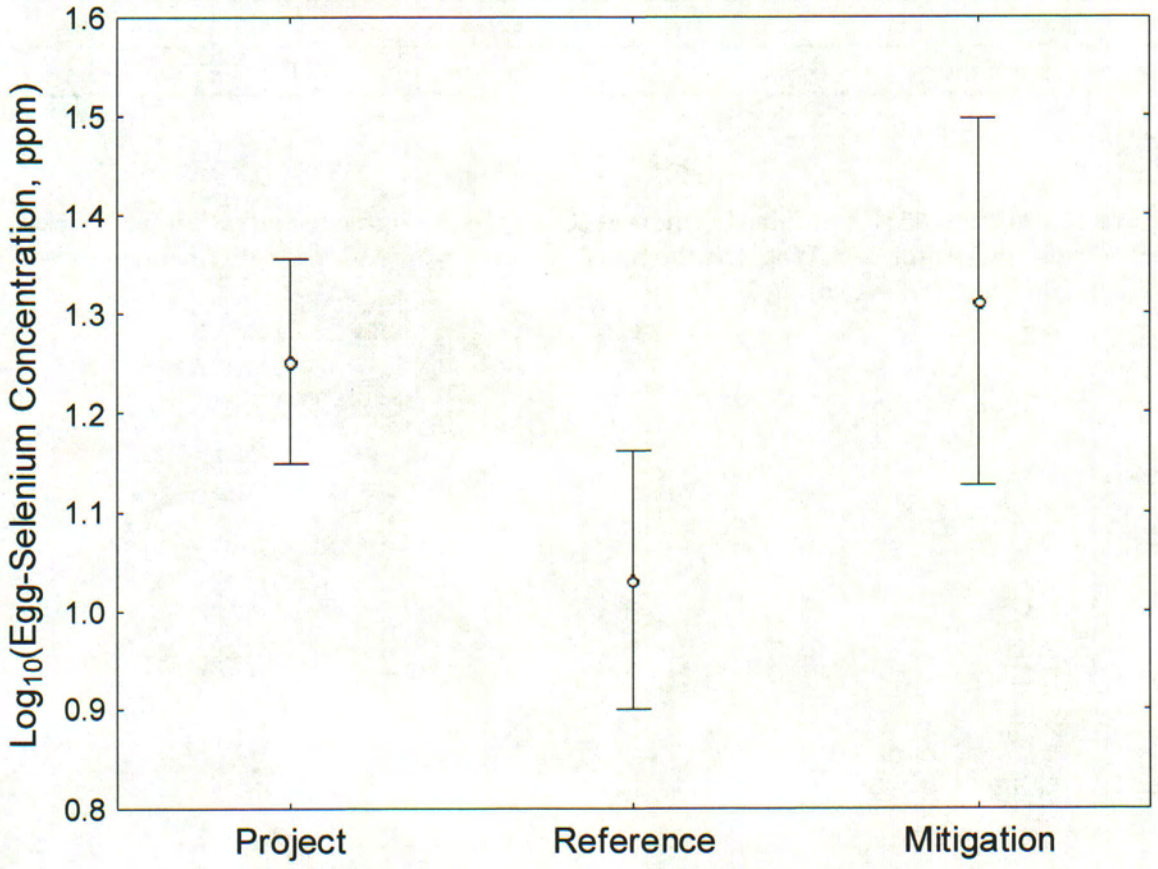
Figure 13. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for Black-necked Stilt and American Avocet at the San Joaquin River Water Quality Improvement Project (2003 to 2007, excluding 2005).



Recurvirostrid Mitigation Site Selenium Concentrations

In 2007, egg-selenium concentrations in recurvirostrids were different between the project and reference sites ($F_{2,28} = 4.776$, $P = 0.016$), but project (16.7 ± 2.5 [SE]) and reference sites (9.7 ± 1.4) did not differ from the mitigation site (19.4 ± 3.9; $P > 0.05$; Figure 14).

Figure 14. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for recurvirostrids at the San Joaquin River Water Quality Improvement Project (2007).



EGG-BORON ANALYSIS

Egg-Boron Data Analysis Between Sites

Boron concentrations were significantly higher in eggs collected from the project site than eggs collected from the reference area for killdeer. Project site recurvirostrid eggs, however, contained significantly less boron than reference area recurvirostrid eggs. There was no significant difference in red-winged blackbird eggs collected from the 2 sites in 2007 (Table 12). The raw boron data are presented in Appendices A, B, and C.

Table 12. Geometric mean egg-boron concentrations from the San Joaquin River Water Quality Improvement Project.

Location	n	Geo. Mean ppm B (dry wt)	Range
Killdeer			
Project Site	7	5.3	2.68-7.99
Off-site Reference Samples	15	2.9	1.66-6.69
Significance difference ($F_{1,20}$ = 9.478, P < 0.006) between sites.			
Recurvirostrids			
Project Site	16	3.2	1.41-8.80
Off-site Reference Samples	10	5.9	1.70-16.5
No significant difference ($F_{1,24}$ = 6.046, P < 0.018) between sites.			
Red-winged blackbirds			
Project Site	11	9.6	6.06-17.4
Off-site Reference Samples	11	7.6	5.50-12.8
Significance difference ($F_{1,20}$ = 3.349, P < 0.082) between sites.			

Egg-Boron Data Analysis Across Years

Egg-boron concentrations in killdeer were 1.8 times greater at the project site (3.9 ± 0.4) than at the reference site (2.2 ± 0.2; H = 29.147, P < 0.001; χ^2 = 29.348, df = 1, P < 0.001), were different among years (H = 27.125, P < 0.001; χ^2 = 16.588, df = 5, P = 0.005; Figure 15), and showed no significant site and year interaction (P = 0.980). In recurvirostrids, egg-boron concentrations were similar between the project site (4.3 ± 0.3 [SE] ppm) and eggs collected from the reference area (4.5 ± 0.6 ppm; H = 1.902, P = 0.168; χ^2 = 2.917, df = 1, P = 0.088). However, there was a significant interaction between site and year (P < 0.001) and no apparent difference between sites for recurvirostrids in any year except 2005 (Figure 16), including 2007 (H = 3.706, P = 0.054; χ^2 = 0.650, df = 1, P = 0.420). Egg-boron concentrations in red-winged blackbirds were not different between sites, although there was a significant interaction between site and year (Table 10, Figure 17); egg-boron concentration was apparently similar between sites in 2003 and 2007, greater at the reference site in 2004, and greater at the project site in 2006.

Figure 15. Mean ± 95% Confidence Interval (CI) egg-boron concentration for killdeer at the San Joaquin River Water Quality Improvement Project (2002 to 2007).

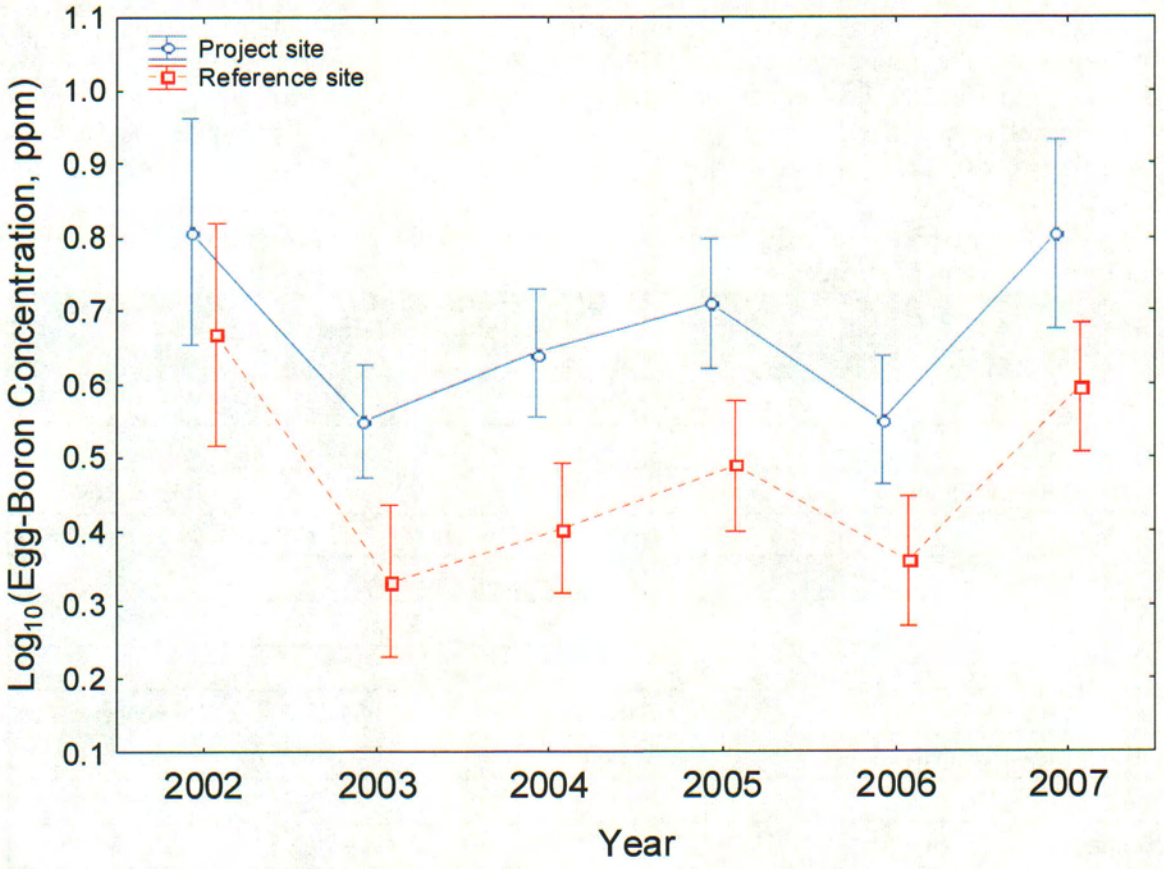


Figure 16. Mean ± 95% Confidence Interval (CI) egg-boron concentration for recurvirostrids at the San Joaquin River Water Quality Improvement Project (2003 to 2007).

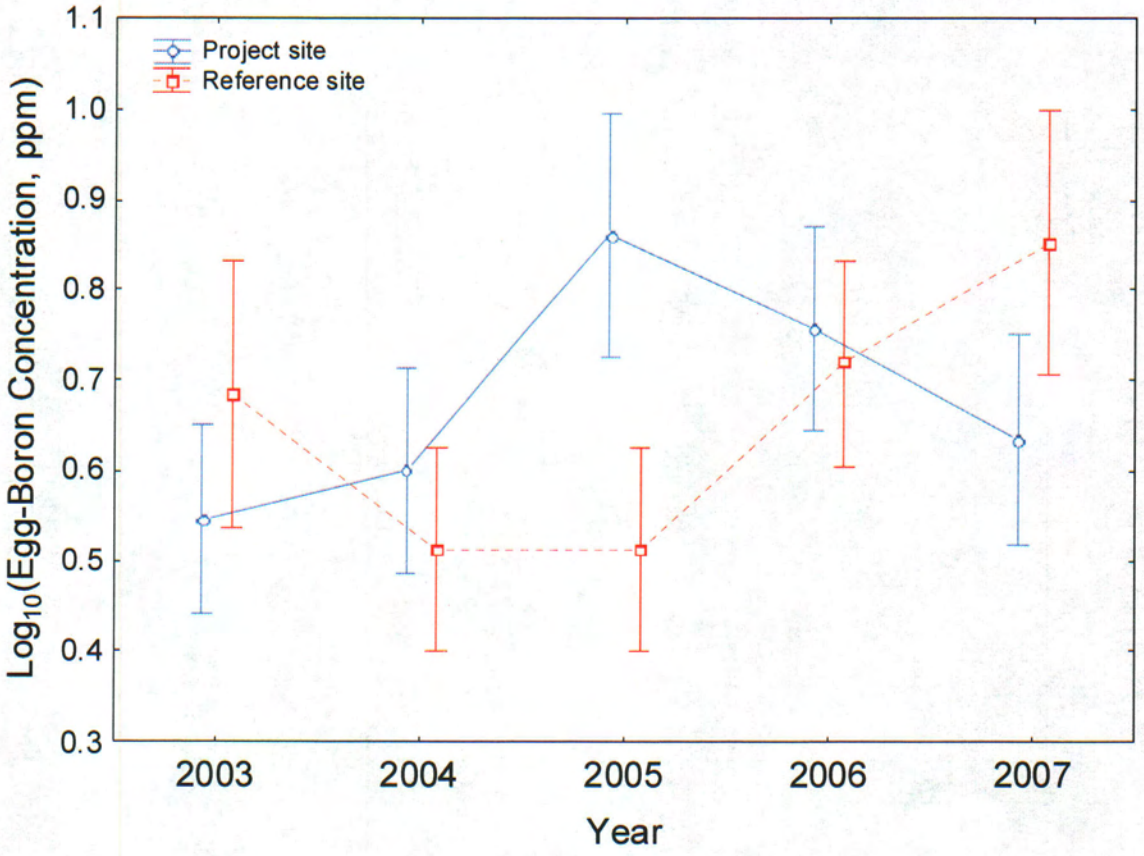
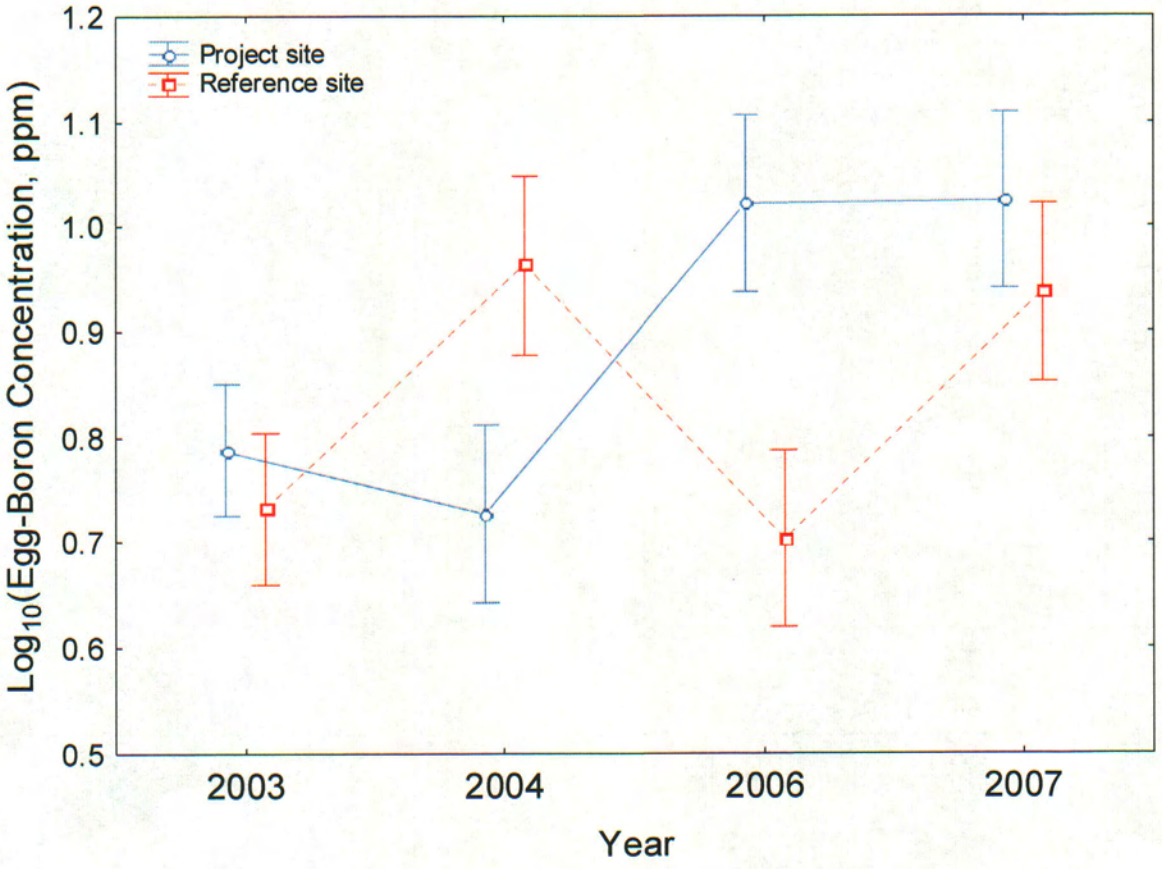


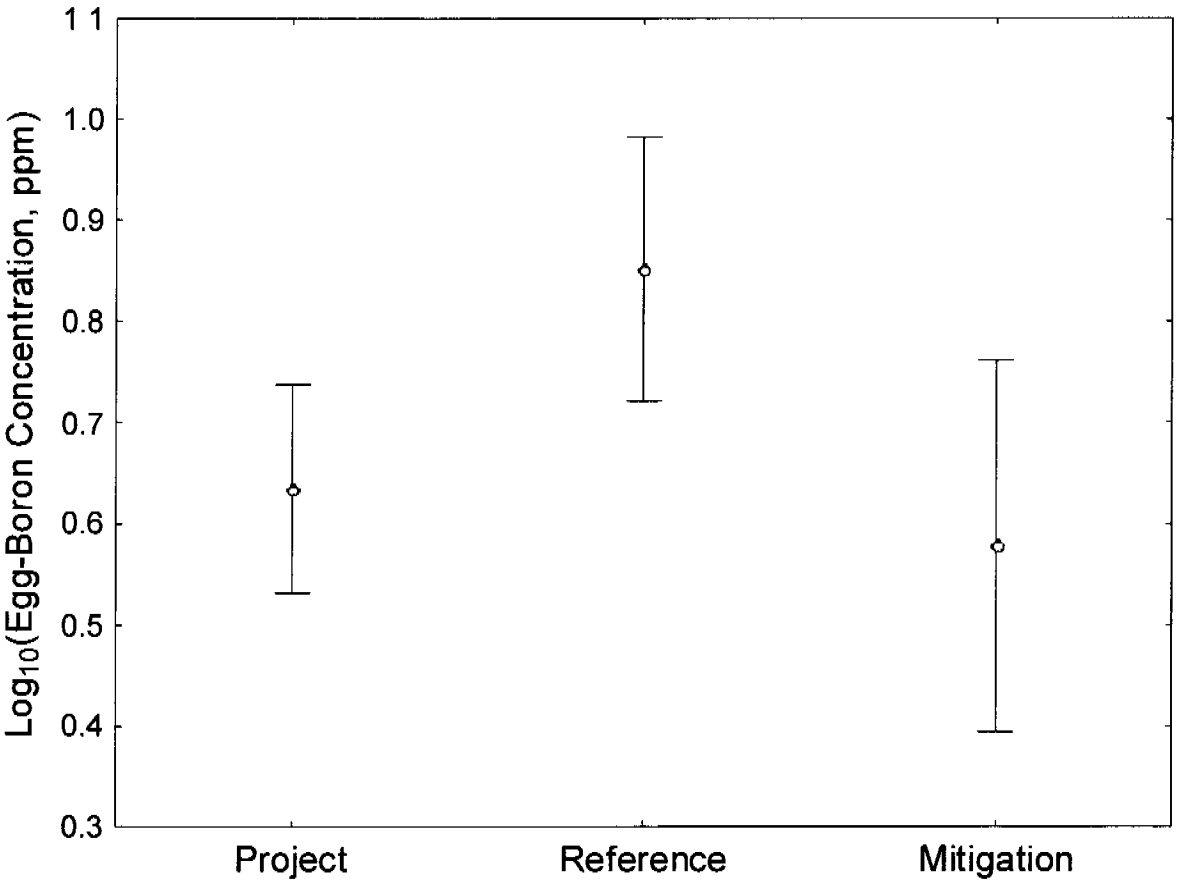
Figure 17. Mean ± 95% Confidence Interval (CI) egg-boron concentration for red-winged blackbirds at the San Joaquin River Water Quality Improvement Project (2003, 2004, and 2007).



Recurvirostrid Mitigation Site Boron Concentrations

Egg-boron concentrations were different among sites ($F_{2,28}$ = 4.612, P = 0.019), and the reference site (7.6 ± 1 7) was 2.1 and 2.6 times greater, respectively, in boron concentration than the project site (3.6 ± 0.4 [SE]) and mitigation site (2.9 ± 0.4, $P < 0.05$: Figure 18).

Figure 18. Mean ± 95% Confidence Interval (CI) egg-boron concentration for recurvirostrids at the San Joaquin River Water Quality Improvement Project (2007).



CONTROL EGGS

The selenium recovery rate for 9 egg samples spiked with selenium ranged between 81.9% and 111% with a mean selenium recovery rate of 103% (Appendix D). Additionally, an average value of 1.72 ug/g Se was obtained on NIST Standard Reference Material 2976 (Mussel) (certified value = 1.80 + 0.15 ug/g). The standard deviation of duplicate egg samples ranged between 0.0000 and 0.5020 with a mean standard deviation of 0.0715 (Appendix E).

The boron recovery rate for 4 egg samples spiked with boron ranged between 99% and 107%, with a mean selenium recovery rate of 102.8% (Appendix F). The standard deviation of boron results from 33 duplicate egg samples ranged between 0.0071 and 0.4738, and the mean standard deviation was 0.1631 (Appendix F).

NEST FATE

Eight killdeer and 17 recurvirostrid nests were followed to completion on the project site in 2007 (Table 13, Appendix G). Five of the killdeer nests hatched, one was lost to predators, and 2 were destroyed by vehicles. Eight of the recurvirostrid nests were depredated. The 9 remaining recurvirostrid nests hatched at least one chick, though one American Avocet nest that appeared to hatch also contained one egg that failed to hatch (Appendix G).

Five killdeer nests and 13 recurvirostrid nests were monitored at the mitigation site. All 5 of the Killdeer nests and 11 of the recurvirostrid nests hatched successfully. The killdeer and recurvirostrid nests that were located on the islands within the rice field hatched successfully. Predators took both of the recurvirostrid nests that were located on the levees of the rice field (Table 13, Appendix G.)

Table 13. Nest fates and agents that caused nest/clutch success or failure at the San Joaquin River Water Quality Improvement Project Site and Mitigation Site in 2007.

Species	Hatched		Depredated		Abandoned		Vehicle		Total
	Nests	%	Nests	%	Nests	%	Nests	%	
Project Site									
Killdeer	5	*62.5*	1	*12.5*			2	*25*	8
Recurvirostrids	9	*53*	8	*47*					17
Black-necked stilt	*(3)*		*(3)*						*(6)*
American avocet	*(6)*		*(5)*						*(11)*
Total	**14**	***56***	**9**	***36***			**2**	***8***	**25**
Mitigation Site									
Killdeer	5	*100*							**5**
Recurvirostrids	11	*85*	2	*15*					**13**
Black-necked stilt	*(4)*		*(1)*						*(5)*
American avocet	*(7)*		*(1)*						*(8)*
Total	**16**	***89***	**2**	***11***					**18**

PILOT MITIGATION SITE WATER QUALITY

The results of the water-quality analysis for the mitigation site are summarized in Table 14. Selenium and boron concentrations in the water samples from the inlet mitigation site were well below the 2.3 ppb selenium and 5 ppm boron thresholds for safe exposure to wildlife in freshwater (Eisler 1990, Skorupa and Ohlendorf 1991, and Suter 1996).

Table 14. Water quality in samples from the pilot mitigation site.

Electrical conductivity, µhmo/cm	680
Selenium concentration (ppb)	<2
Boron concentration (ppm)	0.35

Water quality sampled on 8 May 2007

DISCUSSION

The census data indicate that the project site is utilized by bird species common in San Joaquin Valley agricultural habitats. Both species diversity and relative abundance are lower than expected in native, undisturbed habitats. The tall vegetation within some pastures provided nesting habitat for red-winged blackbirds. Irrigation of pastures and alfalfa provide temporary foraging opportunities for birds such as white-faced ibis, whimbrels, and blackbirds.

Swainson's hawks (*Buteo swainsoni*), which are listed as threatened by the state of California, were observed foraging on the project site. Two species listed as "species of concern" by the state of California, the burrowing owl (*Athene cunicularia*) and the loggerhead shrike (*Lanius ludovicianus*), were observed nesting on the project site. The black tern (*Chlidonias niger*), another "species of concern," was observed foraging but not nesting on the project site.

The mean egg-selenium levels in killdeer and recurvirostrid eggs at the project site in 2007 were above selenium levels associated with a high probability of reproductive effects, including reduced hatchability and increased occurrence of embryo deformities (teratogenesis) within a population (CH2M-Hill et al. 1993). For a more thorough discussion of established egg-selenium thresholds see the monitoring report for 2005 (H. T Harvey & Associates 2006).

In 2006, 3 measures to avoid and minimize impacts to nesting shorebirds were implemented. These measures included hazing of shorebirds from the project site, modification of open drains to discourage shorebirds from using traditional nest sites, and installation of a pilot mitigation site to provide clean water nesting habitat for shorebirds. These measure were continued in 2007. Several drains were filled in Sections 2 and 3 that prior to filling had attracted killdeer and recurvirostrids that foraged and nested in and along the drains. The drains that could not be closed were covered with netting to prevent bird use. Recurvirostrid nests in Sections 2 and 3 where drains were filled or netted decreased from 8 and 15 in 2005 and 2006, respectively, to zero in 2007.

The pilot mitigation site contained as many islands as possible without having to bring in additional soil. The 18 islands that were constructed throughout the 50-acre pilot mitigation site provided improved nesting habitat for recurvirostrids and killdeer. All of the nests located on the islands successfully hatched, while all of the nests located on the rice levees were depredated.

The mean egg-selenium content of recurvirostrid eggs sampled from the pilot mitigation site was higher than the project site and reference area samples. While egg-selenium content at the project site was significantly greater than the reference site, the egg-selenium content of the mitigation site was not significantly different than the project or reference sites due to the large variation in egg-selenium content values. Recurvirostrid egg-selenium means from the pilot mitigation site in 2006 and 2007 of 10.6 ppm and 19.4 ppm were both considerably higher than the mean of 5.3 ppm from a set of 10 Black-necked Stilt eggs collected from a rice field north of the project site in 2003. For this reason, in 2008, the pilot mitigation site will be moved north of the 2006 and 2007 sites.

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APPENDIX A. 2007 KILLDEER EGG-BORON CONCENTRATIONS AT THE SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area			
ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log	ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log
01	7.29	0.8627		01	6.22	0.7938	
02	7.99	0.9025		02	3.93	0.5944	
03	2.68	0.4281		03	3.44	0.5366	
04	6.08	0.7839		04	6.69	0.8254	
05	3.53	0.5478		05	4.58	0.6609	
06	6.15	0.7889		06	2.00	0.3010	
07	5.82	0.7649		07	2.03	0.3075	
				08	2.19	0.3404	
				09	1.84	0.2648	
				10	3.53	0.5478	
				11	2.23	0.3483	
				12	1.66	0.2201	
				13	1.75	0.2430	
				14	2.08	0.3181	
				15	3.53	0.5478	
Arith/Geo Mean	5.65	0.7256	*5.3*	Arith/Geo Mean	3.18	0.4567	*2.9*
SD	1.9	0.1728	*1.5*	SD	1.6	0.2005	*1.6*
SE		0.0773	*1.2*	SE		0.0897	*1.2*
95% CI		0.5741	*3.8*	95% CI		0.2809	*1.9*
		0.8770	*7.5*			0.6324	*4.3*

APPENDIX B. 2007 RECURVIROSTRID EGG-BORON CONCENTRATIONS AT THE SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area				Mitigation Site			
ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log	ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log	ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log
01	8.80	0.9445		01	15.1	1.1790		01	3.89	0.5899	
02	4.68	0.6702		02	10.7	1.0294		02	1.91	0.2810	
03	2.69	0.4298		03	9.57	0.9809		03	3.80	0.5798	
04	5.04	0.7024		04	16.5	1.2175		04	2.54	0.4048	
05	3.89	0.5899		05	8.12	0.9096		05	2.22	0.3464	
06	2.00	0.3010		06	3.18	0.5024					
07	1.41	0.1492		07	5.14	0.7110					
08	1.70	0.2304		08	2.73	0.4362					
09	2.73	0.4362		09	3.09	0.4900					
10	3.66	0.5635		10	1.70	0.2304					
11	3.09	0.4900									
12	3.98	0.5999									
13	2.82	0.4502									
14	2.05	0.3118									
15	3.98	0.5999									
16	4.88	0.6884									
Arith/Geo Mean	3.59	0.5098	*3.2*	Arith/Geo	7.58	0.7686	*5.9*	Arith/Geo Mean	2.9	0.4404	*2.8*
SD	1.79	0.2026	*1.6*	SD	5.31	0.3423	*2.2*	SD	0.9	0.1390	*1.4*
SE		0.0906	*1.2*	SE		0.1531	*1.4*	SE		0.0622	*1.2*
95% CI		0.3322	*2.1*	95% CI		0.4686	*2.9*	95% CI		0.3185	*2.1*
		0.6874	*4.9*			1.0687	*11.7*			0.5622	*3.6*

APPENDIX C. RED-WINGED BLACKBIRD EGG-BORON CONCENTRATIONS AT THE SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area			
ID Number	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**	**ID Number**	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**
01	8.39	0.9238		01	6.15	0.7889	
02	17.4	1.2405		02	10.1	1.0043	
03	10.2	1.0086		03	9.26	0.9666	
04	9.07	0.9576		04	6.45	0.8096	
05	14.1	1.1492		05	7.07	0.8494	
06	10.3	1.0128		06	6.56	0.8169	
07	6.68	0.8248		07	12.8	1.1072	
08	10.1	1.0043		08	10.3	1.0128	
09	9.97	0.9987		09	5.50	0.7404	
10	7.77	0.8904		10	6.47	0.8109	
11	6.06	0.7825		11	6.37	0.8041	
Arith/**Geo Mean**	10.00	0.9812	***9.6***	Arith/**Geo Mean**	7.91	0.8828	***7.6***
SD	3.27	0.1320	***1.4***	SD	2.33	0.1185	***1.3***
SE		0.0590	***1.1***	SE		0.0530	***1.1***
95% CI		0.8655	***7.3***	95% CI		0.7790	***6.0***
		1.0969	***12.5***			0.9867	***9.7***

APPENDIX D. CONTROL EGGS SELENIUM SPIKE RESULTS.

ID Number	Tissue	Spiked Selenium (ug)	% Recovery
PD-P-K-07	egg	0.08	107
PD-R-K-08	egg	0.08	99.9
PD-R-K-14	egg	0.08	105
PD-P-Rc-08	egg	0.08	81.9
PD-P-Rc-14	egg	0.08	101
PD-R-Rc-09	egg	0.08	111
PD-P-B-05	egg	0.08	103
PD-P-B-10	egg	0.08	109
LHM-02	egg	0.08	110
		Mean	**103.1**
		Standard deviation	**8.9**

Additionally, an average value of 1.72 ug/g Se was obtained on NIST Standard Reference Material 2976 (Mussel) (certified value = 1.80 + 0.15 ug/g).

APPENDIX E. 2007 CONTROL EGGS SELENIUM DUPLICATE RESULTS.

SD = Standard Deviation

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PK-1	1	2.96	RK-5	1	1.6200
	2	3.06		2	1.7200
SD		***0.0707***	***SD***		***0.0707***
PK-2	1	4.09	RK-6	1	1.06
	2	4.39		2	1.12
SD		***0.2121***	***SD***		***0.0424***
PK-3	1	3.02	RK-7	1	0.851
	2	3.20		2	0.901
SD		***0.1273***	***SD***		***0.0354***
PK-4	1	8.65	RK-8	1	0.569
	2	9.36		2	0.652
SD		***0.5020***		3	0.592
PK-5	1	1.86		4	0.618
	2	2.01	***SD***		***0.0356***
SD		***0.1061***	RK-9	1	1.24
PK-6	1	7.45		2	1.37
	2	7.67	***SD***		***0.0919***
SD		***0.1556***	RK-10	1	0.991
PK-7	1	3.43		2	1.10
	2	3.36	***SD***		***0.0771***
SD		***0.0495***	RK-11	1	1.03
RK-1	1	0.85		2	1.10
	2	0.953	***SD***		***0.0495***
	3	0.891	RK-12	1	0.921
	4	0.883		2	0.957
SD		***0.0430***	***SD***		***0.0255***
RK-2	1	1.18	RK-13	1	0.724
	2	1.25		2	0.739
SD		***0.0495***		3	0.764
RK-3	1	1.49	***SD***		***0.0202***
	2	1.55	RK-14	1	0.813
SD		***0.0424***		2	0.896
RK-4	1	0.959	***SD***		***0.0587***
	2	0.997			
SD		***0.0269***			

APPENDIX E. 2007 CONTROL EGGS SELENIUM DUPLICATE RESULTS.

SD = Standard Deviation

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
RK-15	1	1.02	PR-10	1	3.27
	2	1.11		2	3.59
SD		***0.0636***		3	3.83
PR-1	1	4.46		4	3.30
	2	4.80	***SD***		***0.2645***
SD		***0.2404***	PR-11	1	4.43
PR-2	1	7.69		2	4.36
	2	7.70	***SD***		***0.0495***
SD		***0.0071***	PR-12	1	4.77
PR-3	1	7.74		2	5.17
	2	7.45	***SD***		***0.2828***
	3	7.74	PR-13	1	2.66
SD		***0.1674***		2	2.62
PR-4	1	9.62	***SD***		***0.0283***
	2	10.3	PR-14	1	1.18
SD		***0.4808***		2	1.16
PR-5	1	6.48	***SD***		***0.0141***
	2	7.27	PR-15	1	2.17
	3	6.95		2	2.18
	4	7.23	***SD***		***0.0071***
SD		***0.3640***	PR-16	1	3.87
PR-6	1	5.13		2	3.97
	2	5.81	***SD***		***0.0707***
	3	5.52	RR-1	1	1.79
	4	5.74		2	1.67
SD		***0.3061***	***SD***		***0.0849***
PR-7	1	2.96	RR-2	1	1.61
	2	2.87		2	1.53
SD		***0.0636***	***SD***		***0.0566***
PR-8	1	2.24	RR-3	1	1.72
	2	2.26		2	1.66
SD		***0.0141***	***SD***		***0.0424***
PR-9	1	3.47	RR-4	1	2.14
	2	3.49		2	2.10
SD		***0.0141***	***SD***		***0.0283***

APPENDIX E. 2007 CONTROL EGGS SELENIUM DUPLICATE RESULTS.

SD = Standard Deviation

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
RR-5	1	3.86	PB-8	1	1.6
	2	3.79		2	1.6
SD		***0.0495***	***SD***		***0.0000***
RR-6	1	2.12	PB-9	1	1.28
	2	2.14		2	1.27
SD		***0.0141***	***SD***		***0.0071***
RR-8	1	1.30	PB-10	1	1.25
	2	1.26		2	1.25
SD		***0.0283***	***SD***		***0.0000***
RR-7	1	3.28	PB-11	1	1.07
	2	3.15		2	1 10
SD		***0.0919***	***SD***		***0.0212***
RR-9	1	3.56	RB-1	1	0.70
	2	3.39		2	0.69
SD		***0.1202***	***SD***		***0.0049***
RR-10	1	2.71	RB-2	1	0.564
	2	2.64		2	0.583
SD		***0.0495***	***SD***		***0.0134***
PB-1	1	1.2	RB-3	1	0.57
	2	1.2		2	0.542
SD		***0.0000***	***SD***		***0.0198***
PB-4	1	1.01	RB-4	1	0.43
	2	1.02		2	0.439
SD		***0.0071***	***SD***		***0.0064***
PB-5	1	1.03	RB-6	1	0.428
	2	1.05		2	0.421
SD		***0.0141***	***SD***		***0.0049***
PB-6	1	1.07	RB-7	1	0.531
	2	1.03		2	0.545
SD		***0.0283***	***SD***		***0.0099***
PB-7	1	0.959	RB-8	1	0.561
	2	0.937		2	0.56
SD		***0.0156***	***SD***		***0.0007***

APPENDIX E. 2007 CONTROL EGGS SELENIUM DUPLICATE RESULTS.

SD = Standard Deviation

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
RB-9	1	0.50	TLDD-C-2	1	0.714
	2	0.493		2	0.714
SD		***0.0049***	***SD***		***0.0000***
RB-10	1	0.429	RB-11	1	0.722
	2	0.417		2	0.719
SD		***0.0085***	***SD***		***0.0021***
RB-11	1	0.722	MIT-1	1	8.86
	2	0.719		2	8.85
SD		***0.0021***	***SD***		***0.0071***
MIT-1	1	8.86	MIT-2	1	7.00
	2	8.85		2	6.84
SD		***0.0071***	***SD***		***0.1131***
MIT-2	1	7.00	MIT-3	1	2.73
	2	6.84		2	2.76
SD		***0.1131***	***SD***		***0.0212***
MIT-3	1	2.73	MIT-4	1	4.25
	2	2.76		2	4.28
SD		***0.0212***	***SD***		***0.0212***
MIT-4	1	4.25	MIT-5	1	4.27
	2	4.28		2	4.49
SD		***0.0212***	***SD***		***0.1556***
MIT-5	1	4.27	TLDD-C-3	1	0.613
	2	4.49		2	0.578
SD		***0.1556***	***SD***		***0.0247***
LHE-1	1	5.85	TLDD-C-4	1	0.483
	2	6.01		2	0.518
SD		***0.1131***	***SD***		***0.0247***
TLDD-C-1	1	0.948	TLDD-C-5	1	0.522
	2	0.891		2	0.54
SD		***0.0403***	***SD***		***0.0127***
		0.714	WLS-1	1	2.23
		0.714		2	2.16
Mean SD	0.0715	***0.0000***	***SD***		***0.0495***
Low SD:	0.0000				
High SD:	0.5020				

APPENDIX F. CONTROL EGGS BORON RESULTS.

Boron Control Spikes.

ID Number	Tissue	Spiked Boron (ug)	% Recovery
PDP-K-13	egg	Not reported	107
PD-R-K-09	egg	Not reported	102
PD-R-Rc-12	egg	Not reported	103
PD-M-R-02	egg	Not reported	99
		Mean	**102.8**
		Standard deviation	**3.3**

2007 Control Eggs Boron Duplicate Results

SD = Standard Deviation

ID Number	*Replication*	*Result Boron*	*ID Number*	*Replication*	*Result Boron*
PK-1	1	1.96	RK-1	1	1.50
	2	1.95		2	1.51
SD		***0.0071***		3	2.16
PK-2	1	2.41	***SD***		***0.3782***
	2	1.99	RK-5	1	1 12
	3	1.91		2	1 13
	4	1.93		3	1.24
SD		***0.2358***	***SD***		***0.0666***
PK-3	1	0.73	RK-7	1	0.46
	2	0.84		2	0.47
SD		***0.0778***		3	0.53
PK-4	1	1.65	***SD***		***0.0379***
	2	1.61	RK-8	1	0.62
SD		***0.0283***		2	0.58
PK-5	1	1.510		3	0.63
	2	0.729	***SD***		***0.0265***
	3	0.789	RK-11	1	0.589
	4	0.899		2	0.489
SD		***0.3591***		3	0.729
PK-6	1	2.07		4	0.629
	2	1.31	***SD***		***0.0993***
	3	1.50	RK-12	1	0.51
	4	1 78		2	0.37
SD		***0.3319***	***SD***		***0.0990***

2007 Control Eggs Boron Duplicate Results

SD = Standard Deviation

ID Number	*Replication*	*Result Boron*	*ID Number*	*Replication*	*Result Boron*
RK-13	1	0.541	PR-14	1	0.569
	2	0.391		2	0.439
	3	0.481	***SD***		***0.0919***
SD		***0.0755***	PR-15	1	1 16
PR-1	1	1.92		2	0.791
	2	2.34	***SD***		***0.2609***
	3	2.37	RR-1	1	3.72
SD		***0.2516***		2	3.33
PR-2	1	1.44		3	3.11
	2	1.00	***SD***		***0.3089***
	3	1.01	RR-3	1	2.52
SD		***0.2512***		2	2.19
PR-3	1	0.629	***SD***		***0.2333***
	2	0.539	RR-4	1	4.15
SD		***0.0636***		2	3.82
PR-5	1	1.31	***SD***		***0.2333***
	2	0.869	RR-6	1	0.74
	3	0.669		2	0.61
	4	0.849	***SD***		***0.0919***
	5	1.050	RR-7	1	1.44
SD		***0.2425***		2	1.35
PR-7	1	0.23	***SD***		***0.0636***
	2	0.441	RR-10	1	0.379
	3	0.33		2	0.389
SD		***0.1055***		3	0.299
PR-8	1	0.34	***SD***		***0.0493***
	2	0.46	PB-8	1	1.00
SD		***0.0849***		2	1.67
PR-9	1	0.569	***SD***		***0.4738***
	2	0.789	RB-5	1	1.09
SD		***0.1556***		2	1.27
PR-10	1	0.909	***SD***		***0.1273***
	2	0.759	**Mean SD**	0.1631	
	3	0.909	**Low SD:**	0.0071	
SD		***0.0866***	**High SD:**	0.4738	

APPENDIX G. KILLDEER AND RECURVIROSTRID NEST SURVEY RESULTS FOR THE SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT AND PILOT MITIGATION SITES

Killdeer Nest Survey Results For The San Joaquin River Water Quality Improvement Project Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Killdeer														
001	Section 3	road edge	05/16	4	05/23	3	05/30	3	06/06	3	PK-1 collected 5/16, 6/14 0 eggs - ph	1	4	1
002	Section 13	road edge	05/16	4	05/23	3	05/30	0			PK-2 collected 5/16, ph	1	4	1
003	Section 3	road edge	05/16	4	05/23	3	05/30	3	06/06	3	PK-3 collected 5/16, 6/14 0 eggs - ph	1	4	1
004	Section 3	levee	05/30	4	06/06	3	06/14	3	06/26	3	PK-4 collected 5/30, 7/3 0 eggs - ph	1	4	1
005	Section 3	road edge	06/14	4	06/19	3	06/26	3	07/03	0	PK-5 collected 6/14, destroyed by vehicle	5	5	7
006	Section 3	equipment yard	06/19	4	06/26	3	07/03	3	07/11	0	PK-6 collected 6/19, ph	1	4	1
007	Section 13	road edge	06/26	4	07/03	3	07/11	0			PK-7 collected 6/26, depredated	5	5	4
008	Section 13	equipment yard	06/26	2	07/03	0					nest destroyed by vehicle	5	5	7

Codes for nest status, nest fate, and nest agent.

Nest status.
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc.)

Nest fate.
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column:
fth = Egg that has failed to hatch
ph = Presumed hatched

Recurvirostrid Nest Survey Results For The San Joaquin River Water Quality Improvement Project Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Black-necked stilt														
001	Section 11	barren field	05/16	4	05/23	3	06/01	3	06/06	3	PR-7 collected 5/16, 6/14 0 eggs ph	1	4	1
002	Section 12	field edge	05/25	4	06/01	3	06/06	3	06/14	3	PR-8 collected 5/25, 6/26 0 eggs - ph	1	4	1
003	Section 10	levee	06/01	2	06/06	4	06/14	3	06/19	3	PR-11 collected 6/6, 6/26 0 eggs - ph	1	4	1
004	Section 10	levee	06/14	4	06/19	3	06/26	0			PR-13 collected 6/14, depredated	5	5	4
005	Section 12	road edge	06/14	4	06/19	3	06/26	0			PR-14 collected 6/14, depredated	5	5	4
006	Section 11	barren field	06/14	4	06/19	3	06/26	0			PR-15 collected 6/14, depredated	5	5	4
American avocet														
001	Section 11	barren field	05/09	4	05/16	3	05/23	3	05/30	0	PR-1 collected 5/9, ph	1	4	1
002	Section 11	barren field	05/09	4	05/16	3	05/23	3	05/30	3	PR-2 collected 5/9, 6/6 0 eggs -ph	1	4	1
003	Section 11	barren field	05/09	4	05/16	3	05/23	3	05/30	0	PR-3 collected 5/9, ph	1	4	1
004	Section 11	barren field	05/09	2	05/16	4	05/23	3	05/30	3	PR-6 collected 5/16, 6/6 0 eggs -ph	1	4	1
005	Section 10	levee	05/16	4	05/23	3	05/30	3	06/06	1	PR-4 collected 5/16, 1 fth	1	4	1
006	Section 11	barren field	05/16	4	05/23	3	05/30	3	06/06	3	PR-5 collected 5/16, 6/14 0 eggs - ph	1	4	1
007	Section 11	barren field	05/30	4	06/06	3	06/14	3	06/19	0	PR-9 collected 5/30, depredated	5	5	4
008	Section 11	barren field	06/01	4	06/06	3	06/14	3	06/19	0	PR-10 collected 6/1, depredated	5	5	4
009	Section 10	levee	06/14	4	06/19	3	06/26	0			PR-12 collected 6/14, depredated	5	5	4
010	Section 12	levee	06/19	4	06/26	0					PR-16 collected 6/19, depredated	5	5	4
011	Section 12	levee	06/19	3	06/26	0					depredated	5	5	4

Codes for nest status, nest fate, and nest agent.

Nest status:
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc)

Nest fate:
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column:
fth = Egg that has failed to hatch
ph = Presumed hatched

Killdeer and Recurvirostrid Nest Survey Results For The San Joaquin River Water Quality Improvement Mitigation Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Killdeer														
001	2	Island	05/25	4	06/01	4	06/06	4	06/19	0		1	4	1
002	7	Island	05/25	4	06/01	4	06/06	4	06/19	0		1	4	1
003	17	Island	05/25	4	06/01	4	06/06	4	06/19	0		1	4	1
004	13	Island	06/01	2	06/06	4	06/19	4	07/03	0		1	4	1
005	5	Island	06/06	4	06/19	4	07/03	0				1	4	1
Black-necked stilt														
001	levee south of 18	Levee	05/18	4	05/25	4	06/01	0			depredated	5	5	4
002	17	Island	05/25	4	06/01	4	06/06	4	06/19	0		1	4	1
003	14	Island	05/25	3	06/01	4	06/06	4	06/19	1	hatching	1	3	1
004	8	Island	06/01	4	06/06	4	06/19	4	07/03	0		1	4	1
005	16	Island	06/01	3	06/06	4	06/19	4	07/03	0		1	4	1
American avocet														
001	1	Island	05/18	4	05/25	3	06/01	3	06/06	0	1 egg collected 5/18, adult w/ 2 chicks nearby	1	3	1
002	levee south of 18	Levee	05/18	4	05/25	3	06/01	0			1 egg collected 5/18, depredated	5	5	4
003	18	Island	05/18	4	05/25	3	06/01	0			1 egg collected 5/18	1	4	1
004	13	Island	05/18	4	05/25	3	06/01	1	06/06	0	1 egg collected 5/18, hatching 6/1	1	3	1
005	14	Island	05/18	3	05/25	4	06/01	4	06/06	0		1	4	1
006	15	Island	05/18	4	05/25	3	06/01	3	06/06	0	1 egg collected 5/18	1	4	1
007	7	Island	05/18	4	05/25	4	06/01	0				1	4	1
008	16	Island	06/01	3	06/06	4	06/19	4	07/03	0		1	4	1

Codes for nest status, nest fate, and nest agent.

Nest status:
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc)

Nest fate
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column.
fth = Egg that has failed to hatch
ph = Presumed hatched

APPENDIX H. CONTINGENCY PLAN FOR BIOLOGICAL MONITORING OF ACCIDENTAL FLOOD EVENTS WITHIN THE PROJECT SITE

San Joaquin River Water Quality Improvement Project
Biological Monitoring Contingency Plan
Prepared 9 February 2007

Background

Panoche Drainage District adopted a negative declaration for the Phase 1 San Joaquin River Water Quality Improvement Project on September 19, 2000. This project provided for the application of subsurface drainage water on salt tolerant crops on lands within the in-valley treatment area known as San Joaquin River Water Quality Improvement Project (SJRIP). The negative declaration was adopted with the following impact avoidance measure: "A biological monitoring program will be developed in collaboration with U.S. Fish and Wildlife Service that would be capable of detecting migratory bird impacts and, if necessary, capable of providing the data for formulating project adjustments to avoid such impacts" (Negative Declaration, page 2, paragraph 5. Impact Avoidance Measures).

The monitoring program was developed with input from the US Fish & Wildlife Service and H. T Harvey & Associates was contracted to perform the monitoring. Monitoring began in the spring of 2001 The monitoring program has been modified based on the initial monitoring in 2001 to respond to the conditions within the SJRIP and has been ongoing annually since then. Modifications have included sampling Red-Winged Blackbird eggs in addition to Black-necked Stilt, American Avocet, and killdeer eggs, sampling eggs from within the project site and from non-project lands in the vicinity of the project, and to significantly increase the number of eggs sampled and analyzed. It was known that the subsurface drainage water that would be applied to the crops within the SJRIP would be fairly high in selenium and it was indicated in the initial study for the project that " .irrigation with drainwater will be monitored/controlled to avoid the ponding of water such that wetlands containing water high in selenium would not be created on the site." (Page 12, CEQA Initial Study). In the spring of 2003, a pasture at the SJRIP attracted waterfowl when it was inadvertently flooded. Stilt and avocet eggs collected near the pasture had elevated selenium concentrations.

Immediate instructions to field staff that operate the SJRIP were not to allow ponding that inadvertently occurred in 2003, consistent with statements in the CEQA Initial Study to avoid ponding water. A procedure has been established to prevent future ponding of this sort. This document further identifies those procedures and establishes a contingency plan in the unlikely event that ponding reoccurs in the future.

Contingency Plan in the Event of Inadvertent Flooding

If inadvertent flooding occurs due to the breakage of a supply canal or delivery facility, ponded water shall be eliminated through the discharge of the water into a tail-water return system or by pumping the water into one of the supply channels in SJRIP or a tail-water return system. This will be performed to prevent any ponding of water over 24 hours on any lands within the SJRIP.

Project field personnel will be tasked with daily monitoring of water conditions on the project site during the breeding season for birds (March through July). Any ponding that occurred would be

reported to the Drainage Coordinator and through him to the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (DFG). Immediate collection of water samples would be made and analyzed for selenium and boron content.

In the event of inadvertent flooding for a period longer than 24 hours, an event specific monitoring plan will be developed to monitor the impacts to bird species resulting from exposure to ponded water. Any monitoring program will include:

1) the date of the event,
2) selenium concentration of the floodwater,
3) number of birds using the flooded area,
4) duration of exposure,

and, if nesting occurs, will also include:

5) selenium and boron concentrations in eggs,
6) hatchability of eggs, and
7) the assessment of collected embryos.

The results would be included in the annual monitoring report and incorporated into the three-year mitigation assessment reports. The exposure effects will be determined using the egg effect equation provided in the Environmental Impact section of this report. This equation was modified for use at this project site from the equation developed by the U.S. Fish and Wildlife Service for use at evaporation basins (USFWS 1995). The number of birds exposed (number of nest attempts at the project site) and the degree of exposure (egg-selenium content) are the biggest factors determining the amount of required mitigation. The USFWS and/or DFG would have the option of collecting supplemental monitoring data and biological samples in full coordination with Panoche Drainage District.

References

[USFWS] U.S. Fish and Wildlife Service. 1995. Compensation habitat protocol for drainwater evaporation basins. Sacramento, CA. 20 pp.